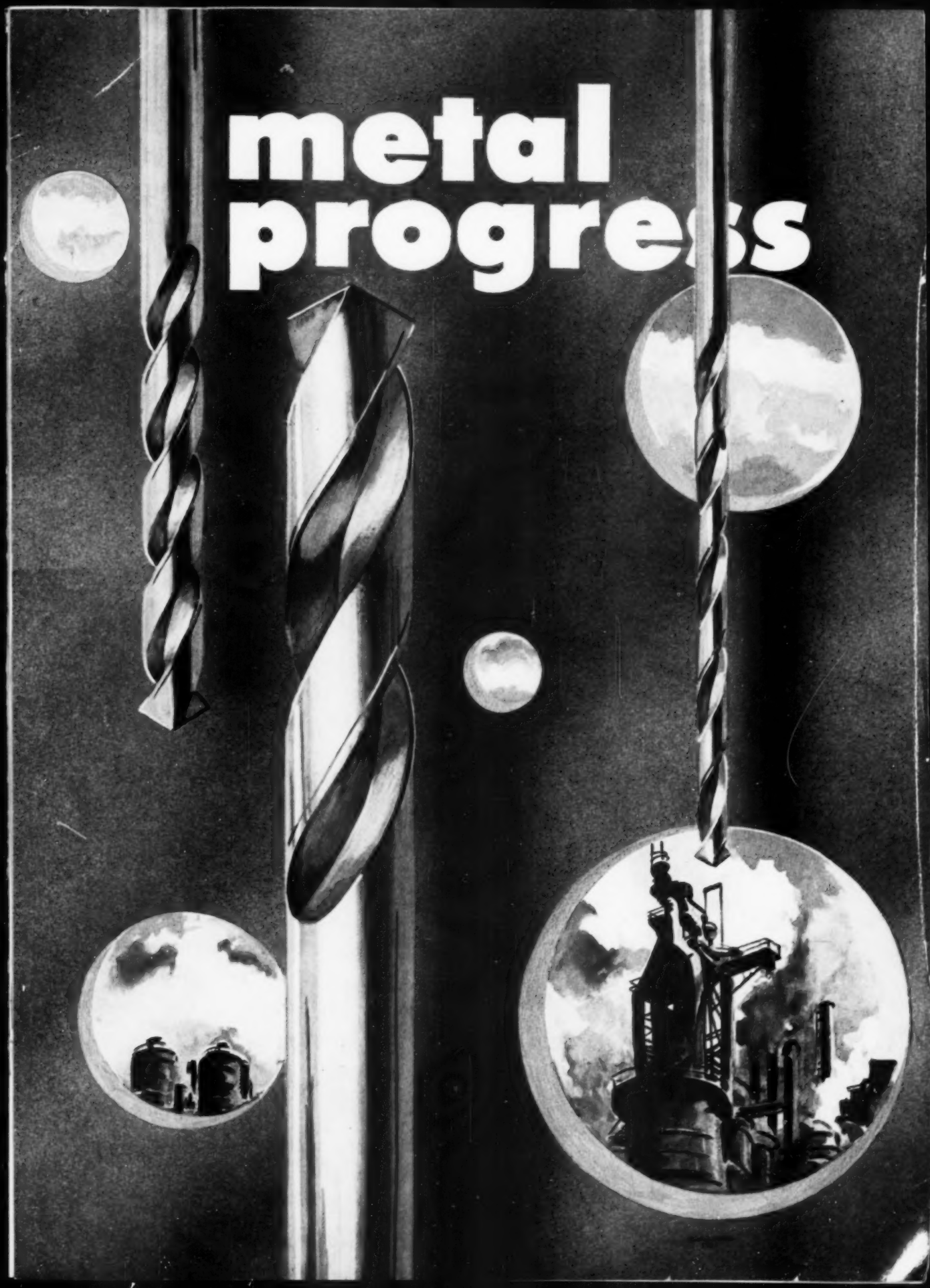
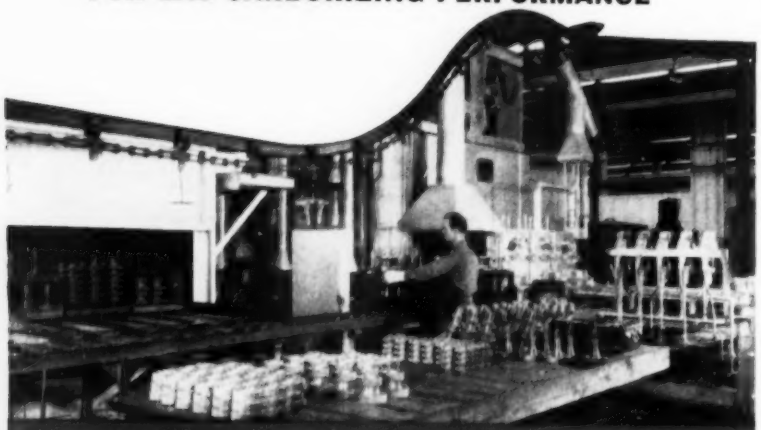
metal progress



FORECASTS

FOR GAS CARBURIZING PERFORMANCE



You'd be amazed (as we are sometimes) at the long memories possessed by some of our furnace engineers. On short notice they'll give you the serial number, location and performance data on furnaces that we installed as long as 10 or 15 years ago — and they're generally right. The point is, the best way to forecast the performance of a furnace not yet built is to check thoroughly the records of similar installations.

BASED ON 22 YEARS OF "HINDSIGHT"

We have built hundreds of gas carburizers for all types of production requirements. If you are interested in continuous gas carburizing for instance, we can point to the first installation of its kind in 1931. It's still doing a job as reported in our sixteen-page bulletin, SC-134, an important and valuable review of gas carburizing techniques and possibilities. Write for it, on your letterhead please.

SURFACE COMBUSTION CORPORATION, TOLEDO 1, OHIO

ALSO MAKERS OF

Kathabar HUMIDITY CONDITIONING

Janitrol AUTOMATIC SPACE HEATING

Current 'Surface' Literature

YOURS FOR THE ASKING

You may find quick answers to your immediate heat treat problems in these recent Surface Combustion Technical Library publications. Ask for the ones most pertinent to your requirements and we'll send them promptly.

bulietins

SC-134	Modern Gas Carburizing
SC-158	RX Prepared Atmosphere Generator
SC-155	Prepared Gas Atmospheres
SC-149	Pit Type Controlled Atmosphere Furnaces
SC-147	Rotary Retort Controlled Atmosphere Furnaces

reprints

53-A	Pit Type Carburizing Furnaces Provide Flexible Setup
52-C	Continuous Carbon Restoration Furnace Boosts Production
49-E	Furnaces for Gas Carburizing
49-B	Homogeneous Carburizing
47-E	Influence of Water Vapor on Gas Carburizing Atmospheres

Surface

HEAT TREATING EQUIPMENT

Metal Progress

July 1, 1954 **Vol. 66, No. 1**

Ernest E. Thum, *Editor*
Marjorie R. Hyslop, *Managing Editor*
John Parina, Jr., *Associate Editor*
Floyd E. Craig, *Art Director*

Cover by Carlos Vasquez

Two issues of *Metal Progress* will be sent to all ASMembers and subscribers in July: This one, dated July 1, 1954, has the usual editorial direction. The second one, dated July 15, 1954, will be confined to reports of 22 technical committees, and, as noted in *Metal Progress* for June, 1954, p. 200, it can be used to supplement the 1948 edition of the A.S.M. Metals Handbook.

Engineering Articles

Heavy Presses Near Completion, by Arthur H. Allen 81

Large areas, thin sections and complicated configurations of light metal forgings for aircraft call for press capacities far beyond anything yet constructed. It is hoped that closed-die hydraulic presses of 35,000 and 50,000 tons capacity will accomplish the task.

Sigma Phase — a Review, by Adolph J. Lena 86

Its effects on the room and elevated-temperature properties of commercially important alloys such as the A.I.S.I. steels with chromium above 17%. It is not always dangerous, because in many of these steels it takes a long time to develop.

Induction Heating Generators as Production Tools, by Peter A. Hassell 94

Success of the high-frequency heating industry depends not only upon the continuing improvement of generators, but also the development of new applications and better and faster handling. Some design considerations and typical installations.

Automatic Carbon Control, by Harold Ipsen and Edward J. Rupert 98

An instrument for automatic control of carbon potential of atmospheres used in batch-type furnaces. Automatic determinations of dew point regulate flow of enrichment gas. Results are reported for carburizing and carbo-nitriding treatments.

Annealing of Titanium, by E. R. Funk 103

Proper temperature for annealing cold worked titanium sheet was appraised by pre-straining tensile samples, annealing 1 hr., and pulling to fracture. Best annealing temperature (1100°F.) gave highest elongation and (inferentially) best drawability.

Cathodic Vacuum Etching, by T. R. Padden and F. M. Cain, Jr. 108

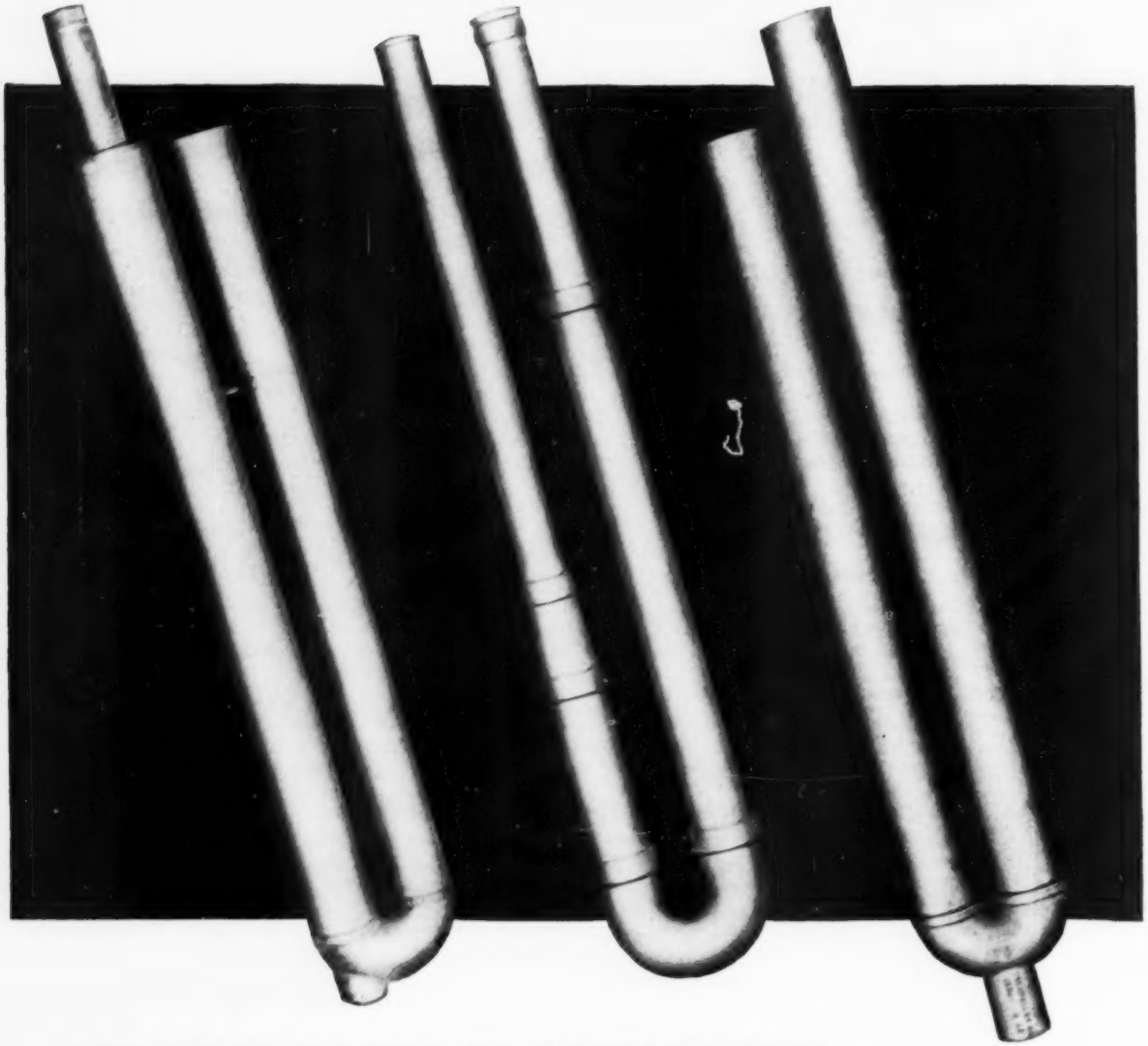
New design of equipment using zirconium fittings and cooled cathode reduces etching time to one to three minutes in standardized routine and handles difficult compacts and couples as easily as the common metals and alloys.

Kanigen Nickel Plating, by Gregoire Gutzeit 113

Nickel plating by chemical catalytic action differs from electroplating in that neither current nor electrodes are required. The "throwing power" of the bath is infinite and there is no variation in plating thickness, even for complicated shapes. Patents reveal some of the chemistry of the process for the first time.

Table of Contents Continued on Page 3

Copyright, 1954, by AMERICAN SOCIETY FOR METALS, 7301 Euclid Ave., Cleveland 3, Ohio. Published monthly; subscription $7.50 a year in U.S. and Canada; foreign $10.50. Single copies $1.50; special issues $3.00. Entered as second class matter at the Post Office in Mt. Morris, Ill.... The AMERICAN SOCIETY FOR METALS is not responsible for statements or opinions printed in this publication.... Requests for change in address should include *old* address of the subscriber; missing numbers due to "change of address" cannot be replaced. Claims for non-delivery must be made within 60 days.



GET MORE HOURS OF SERVICE FROM

Thermalloy* radiant tubes

Make Electro-Alloys your source if you want radiant tube assemblies that will give more life and reduce maintenance costs.

All components are produced in suitable analyses under close metallurgical supervision, and with X-ray control. The straight tube sections are centrifugally cast in such a way that wall thickness is uniform throughout; i. e., inside diameter and outside diameter are concentric, and thickness is the same the full length of the tube. All finished assemblies are pressure-tested before shipment to insure freedom from leakage. As a result, you are assured of radiant tube assemblies that last longer without cracking, warping or sagging.

Whatever your needs in radiant tube assemblies or other heat-treating equipment—you'll get more operating economy from high heat-resistant Thermalloy castings. Let us know your requirements. Call your nearest Electro-Alloys engineer or write Electro-Alloys Division, 5002 Taylor Street, Elyria, Ohio.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

ELYRIA, OHIO

*Reg. U. S. Pat. Off

Table of Contents Continued

Light Metallurgy **Fatigue, by R. P. Lister** 91

Why it so rarely happens to turbine blades when they waggle is explained as one of the minor miracles of science and major mercies of Providence.

Notebook **Formation of Graphite Nodules, by Albert De Sy** 92

Growth is ascribed to a mechanism analogous to a peritectic transformation. This theory satisfactorily explains several well-known characteristics of nodular iron.

The Atomic Age **A.E.C.'s Program for Power Development** 97

A fundamental question still to be answered is whether a power-producing uranium reactor can be built which will compete with other sources of energy. Commissioner Henry D. Smith outlined six lines of investigation that the Atomic Energy Commission should pursue in a five-year program.

Book Review **"Aluminum in Iron and Steel", reviewed by Frank G. Norris** 106

This latest monograph in the Alloys of Iron Research series is by Samuel L. Case and Kent R. Van Horn. The reviewer rambles down some philosophical bypaths before concluding that it is "a book that provides factual answers and also stimulates the reader to ask as many questions as are answered . . . a profitable source of information."

Data Sheet **A.I.S.I. Standard Alloy Steel Compositions** 112-B

Openhearth and electric furnace alloy steels list of February 1954.

Correspondence

Aircraft Engine Valves, 1917, by Basil W. Doncaster 106

A Sheffield firm's first production of stainless steels of cutlery grade.

Australia's Memorial to U.S.A., by Tom Bishop 106

Design and construction of an octagonal aluminum-covered shaft, 258 ft. high, surmounted by an aluminum sphere on which stands an American eagle.

Wartime Work on Bazooka Rockets, by George N. Vitt 108

The first rocket motor tubes blew up at 6000-psi. pressure. This was raised to 40,000 psi. by controlled heat treating and brazing. Credits for the development are sorted out.

Arc Welding of Nodular Irons, by C. L. Hoobler 108

Corrects the inaccurate inference (in a digest published in *Metal Progress*, February 1954) that nodular irons are not weldable.

Digests of Important Articles

Manufacture of Large Forgings 148

Requiring complicated heat treatment and sequence of forging operations.

Techniques Refined for Arc Welding Nodular Irons 150

Nickel-iron cored electrode used for repair and salvage of castings.

British Tests on Welded Pressure Vessels 156

"Stress probing" technique, and cyclic loading, determines stresses on inside and outside.

Screening Test for Cast Stainless Steels 166

Preliminary electrolytic etch in 10% oxalic spots corrodible castings.

Comparison of Costs in Openhearth and Electric Furnace Shops 168

Small steel plant would do well to install electrics.

Properties of Al-Mg-Si Alloys Containing Iron, Manganese or Chromium 178

Mechanical properties, corrosion resistance, metallography.

Thread Inserts of 18-8 Stainless for Magnesium Components 184

Inserts resemble coiled springs and easily replace costly threading of holes.

Departments

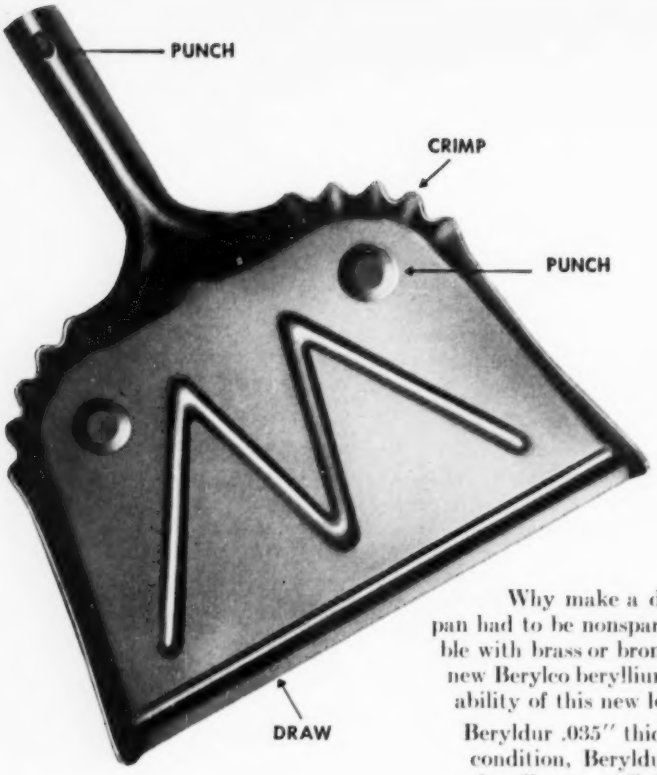
As I Was Saying, by Bill Eisenman 3

Personals 125

Engineering Digest of New Products 13

Manufacturers' Literature 23

Advertisers' Index 192



Beryldur-

A NEW, LOW-COST, EASY-TO-WORK BERYLCO BERYLLIUM COPPER ALLOY

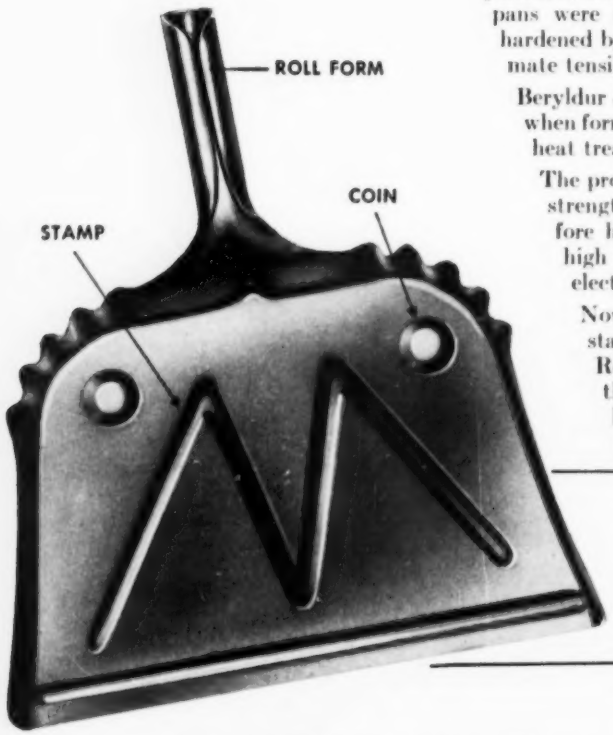
Why make a dustpan out of beryllium copper? In this case, the pan had to be nonsparking, yet stronger and harder than would be possible with brass or bronze. In fabricating the pan from Beryldur, a brand-new Berylco beryllium copper alloy, the makers demonstrated the workability of this new low-cost material.

Beryldur .035" thick was supplied in the annealed temper. In this condition, Beryldur is easy to form, as the illustration shows. The handle was roll formed and punched; the body stamped, drawn, punched, crimped and coined. The same dies used for making steel pans were employed without modification. The pan was then hardened by a simple low-temperature heat treatment to an ultimate tensile of 125,000 to 140,000 psi.

Beryldur can also be supplied in a mill-hardened temper for use when forming requirements are not severe, thus saving the cost of heat treating.

The properties of Beryldur are midway between those of high-strength and high-conductivity Berylco alloys. Beryldur therefore has higher tensile strength than brass or bronze, plus high fatigue strength, great resistance to wear, and good electrical conductivity.

Now for the first time, Beryldur makes available the outstanding properties of beryllium copper at lower prices. Remember, too, you save not only in initial cost, but through reduced fabrication costs and reduction of rejects. For sample material or engineering help, call or write any of the offices listed below.



FURTHER INFORMATION ABOUT BERYLDUR is contained in this 4-page folder. Send for your free copy today.

TOMORROW'S PRODUCTS ARE PLANNED TODAY —WITH BERYLCO BERYLLIUM COPPER



BERYLCO

THE BERYLLIUM CORPORATION, Dept. 4-G, READING 9, PENNA.

New York • Springfield, Mass. • Rochester, N. Y. • Philadelphia • Cleveland • Dayton • Detroit
Chicago • Minneapolis • San Francisco • Los Angeles

Warehouse distributors in principal cities



As I was saying...

PRESIDENT Jim Austin was attending a Man Power Commission meeting at Princeton University last week when in the midst of a long discussion about how the shortage of engineers could and should be met a well-informed college dean spoke up and said, "Take a look at the American Society for Metals. There's an organization that's doing something about it." Jim was all puffed up and so was I when he told me about it. And so that you too can get that pent-up feeling, I am going to outline briefly just what the college dean was talking about.

Here is what the ASM is doing about the engineering shortage: **On the University Level:** 1) The ASM scholarships, 50 in number annually (value $400 each) by the ASM Foundation for Education and Research to undergraduates entering in metallurgical departments; 2) ASM Teaching Awards, $2000 in cash made annually to junior members of metallurgical faculties for excellence of teaching performance; 3) The ASM Graduate Fellowship in Metallurgy, an opportunity for a recent graduate after one year in industry to return to school for advanced study in metallurgy — value $3600; 4) Supports *Acta Metallurgica* with an annual appropriation of $25,000 to this international scientific publication devoted to the theoretical presentation of fundamental metallurgy; 5) Distributes photographs and biographies of graduating metallurgical engineers to 8000 firms in the metals industry; 6) Issues a bulletin of summer jobs available in the metals industry and distributes this information to all engineering students in all engineering schools; 7) Provides Young Engineers' Day in which all undergraduate engineers within 150 miles of the convention city are given an all-expense tour to the annual National Metal Congress and Exposition.

What the ASM is Doing on the Secondary School Level: 1) The ASM Science Achievement Awards, 100 in number annually (value $5000), a nation-wide competition for students in junior and senior high schools, public, private and parochial for original projects in any science, engineering or metals subject conducted through the National Science Teachers' Association; 2) The ASM Science Teaching Awards, $250 in cash, made annually to four science teachers in public, parochial or private schools for their notable programs in science; 3) Teaching the Teachers—the Society organizes and presents (in cooperation with state educational officials) summer courses in metals technology for instructors in vocational, trade and manual training high schools; 4) The science and guidance teachers are contacted by an ASM chapter committee to present information about a career in engineering and metallurgy.

What the ASM is Doing on the Industrial Level: 1) The American Society for Metals exists primarily because of its ability to bring important and new information about the production of metals and alloys and their fabrication and finishing into the hands of its 23,000 members. Only 50% of them have been educated as metallurgists or metallurgical engineers; 2) Chapter Meetings — There are 89 chapters in the industrial centers of the U.S. and Canada, each of which holds monthly technical meetings; 3) Educational Courses — Many chapters organize educational courses (four to six sessions) on important metallurgical topics. In the season just past 67 such courses were presented and attended by 19,374 members and nonmembers; 4) Publications — The annual *Transactions* (fundamental scientific and research contributions), the monthly *Metal Progress* (the engineering magazine of the metals industry), the monthly *ASM Review of Current Metal Literature* (prompt annotated survey of all metallurgical publications), the Metals Handbook (known as the bible of the metals industry), and books on metals all make the American Society for Metals by far the largest publisher of metallurgical information in the world.

What's that I heard someone say? "Bill's blowing his tuba, Eh?" Not quite so — but I'll tell you this. I'd be willing (almost) to blow my top if you could find any large number of members who do not have a feeling of pride in the part your ASM is playing in the present engineering shortage and for the metals industry.

Your contributions and cooperation have made these activities possible and to you should go a Certificate of Distinguished Service.

Cordially,

Bill

W. H. EISENMAN, *Secretary*
AMERICAN SOCIETY FOR METALS

Solventol
DI-PHASE
METAL CLEANING

Removes more types of soil from more kinds of metals than is possible with other cleaning materials . . .

ASK US TO PROVE IT!

•

"Automation"
ADAPTABILITY . . .
is the keynote in the design of this Solventol Washer. Semi-automatic loading of 155 mm. HE projectiles and automatic unloading are but two features of this Solventol designed and built washer.



ASK FOR QUOTATION NO OBLIGATION
SOLVENTOL CHEMICAL PRODUCTS, INC.
DETROIT 3, MICHIGAN

You're known by the Company you keep . . .

and the impressive list of companies who use ACCOLOY Heat and Corrosion Resistant Castings and keep records of their long service life is a very convincing reason why these castings are "preferred by industry".



HEAT RESISTANT CASTINGS
ACCOLOY
STAINLESS STEEL CASTINGS

ALLOY ENGINEERING & CASTING CO.

ALLOY CASTING CO. (Div.)
CHAMPAIGN • ILLINOIS

ENGINEERS AND PRODUCERS OF HEAT AND CORROSION RESISTANT CASTINGS

Only GRAPH-MO® steel rates so high on wearability and machinability and stability

OUTWEARS OTHER TOOL STEELS 3 TO 1
MACHINES 30% FASTER
IS THE MOST STABLE GAGE STEEL MADE

GRAPH-MO® is the only tool steel that combines these advantages.

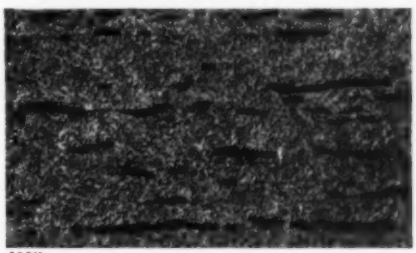
The gages or dies you manufacture or buy will stay accurate longer if they're made from Graph-Mo steel. Tests prove its stability. For example, a typical master plug gage made of Graph-Mo steel showed less than 10 millionths of an inch variation from its original dimensions after 12 years of use!

A combination of free graphite and diamond-hard carbides in the structure of Graph-Mo steel makes it wear longer. Reports from users show that Graph-Mo steel outwears other tool steels on an average of 3 to 1.

The free graphite particles cut production time, too. Constant Pressure Machinability tests show that Graph-Mo steel machines 30% faster than other tool steels. And Graph-Mo steel has minimum tendency to pick up, scuff or gall. Graphite particles act as a "built-in" lubricant. Tests on Amsler Wear Machine show Graph-Mo steel has twice the resistance to galling when compared with ordinary tool steels.



Graph-Mo steel master plug gage (above) used in 12-year stability test. Photomicrograph (below) shows free graphite and diamond-hard carbides that give Graph-Mo unusual wear resistance.



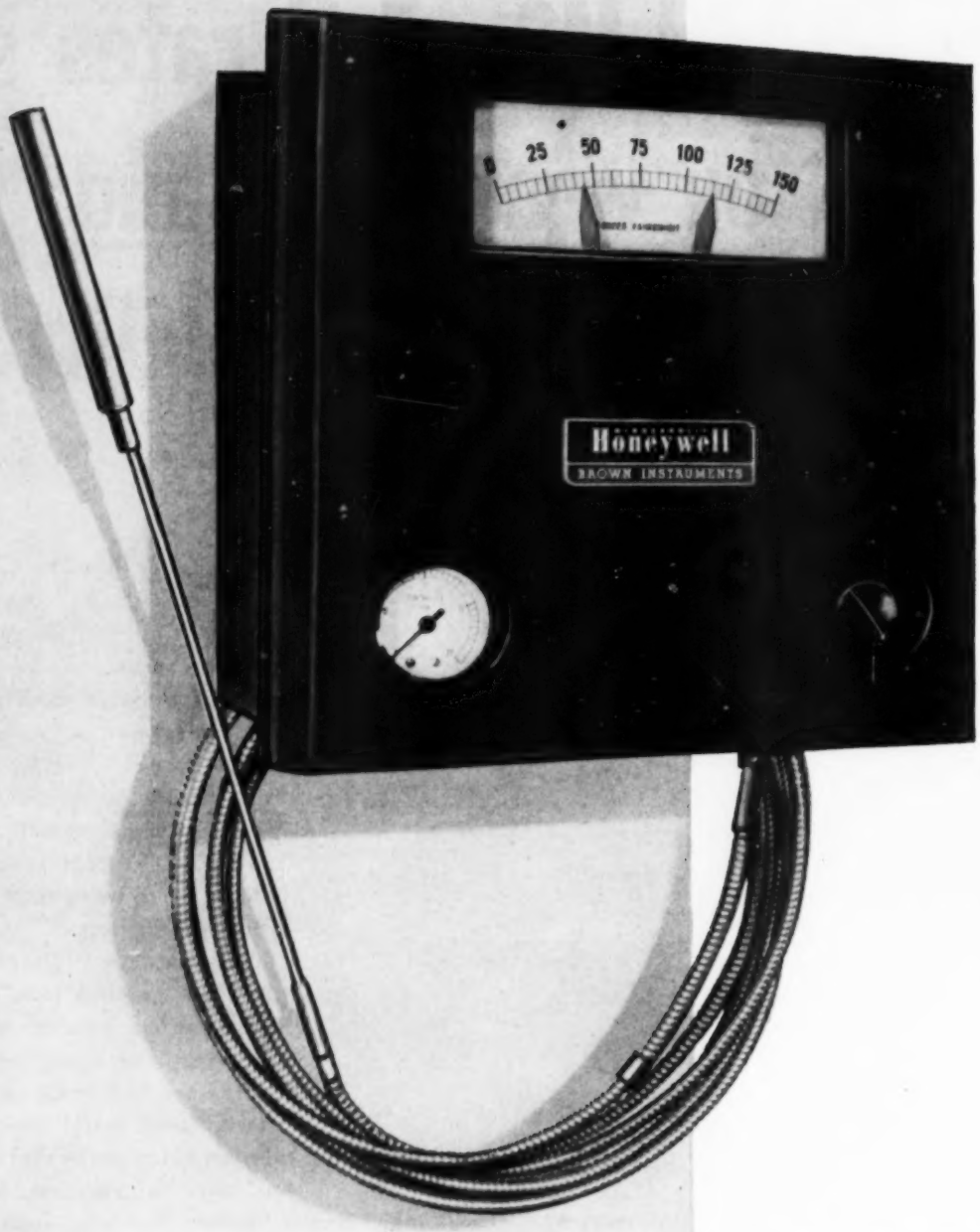
100X

You can always tell Graph-Mo steel by its "graphitic look"—the tiny, scattered, parallel marks barely visible on a piece of polished Graph-Mo. Insist on this built-in "trade-mark" the next time you buy gages or tool steel. For more information, write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



All these quality features—at remarkably low price!

good readability—indicates temperature continuously on 4½" scale.

quick control check—red pointer shows control setting, black pointer indicates temperature.

control air indication—front-mounted gage indicates air pressure to control valve.

variety of control—direct or reverse acting pneumatic control, either on-off or proportional type.

selection of ranges—23 different temperature ranges, up to 1000° F., in Fahrenheit and Centigrade calibrations, for vapor and mercury bulb systems.

compact design—die cast aluminum case 11" x 11", 4" deep; gasketed black plastic cover; practically splashproof. Interchangeable flush or surface mounting on panels of any thickness.

simple setting—external knob for adjusting set point.

need simple, economical temperature control?

Here's the instrument for you

The Brown Pneumatic Thermometer Controller now brings the advantages of automatic temperature control within the reach of practically any process.

If you've an oven, dryer, plating tank or other processing equipment operating below 1000° F. that you thought couldn't afford automatic control, this instrument may be just what you've been looking for.

Ideal for equipment and processes that do not require a record, the controller gives operators a continuous indication of temperature, and affords excellent precision of pneumatically actuated control. The instrument is fast, accurate, and exceptionally simple in design. It takes little space . . . fits readily into existing equipment or on panels.

The instrument, bulb and tubing are one complete unit. An external knob permits easy setting of the control point. A choice of ranges, control actions and thermal systems are available to handle an endless variety of control applications. Although economical in price, this controller embodies precision construction throughout . . . utilizes many of the high-quality components found in other Honeywell products. And it is backed by Honeywell's coast-to-coast service organization.

Your nearby Honeywell sales engineer will be glad to discuss your own plant's applications for this versatile instrument. Call him today . . . he's as near as your phone.

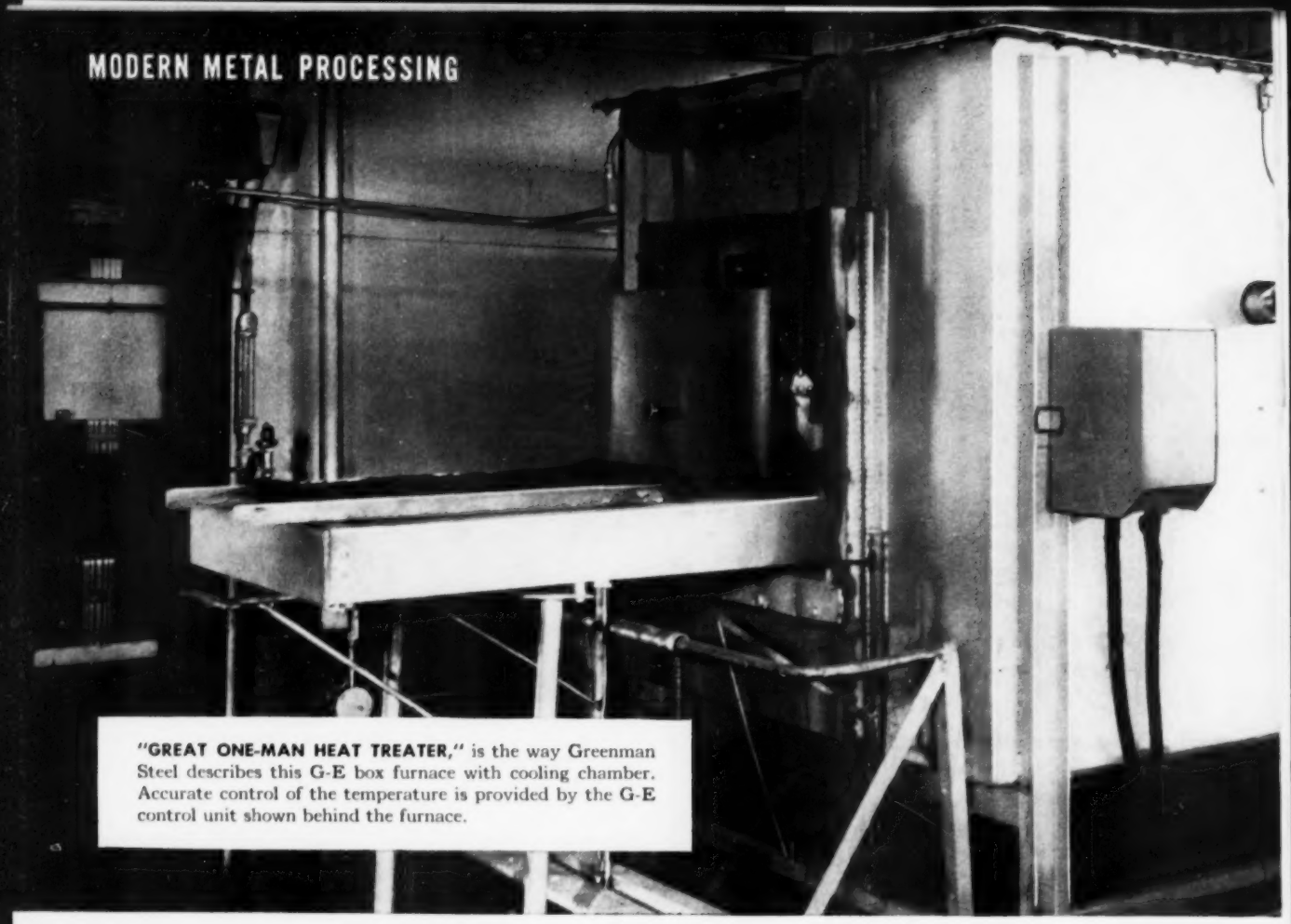
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Write for your copy of Bulletin 6401.**

MINNEAPOLIS **Honeywell**

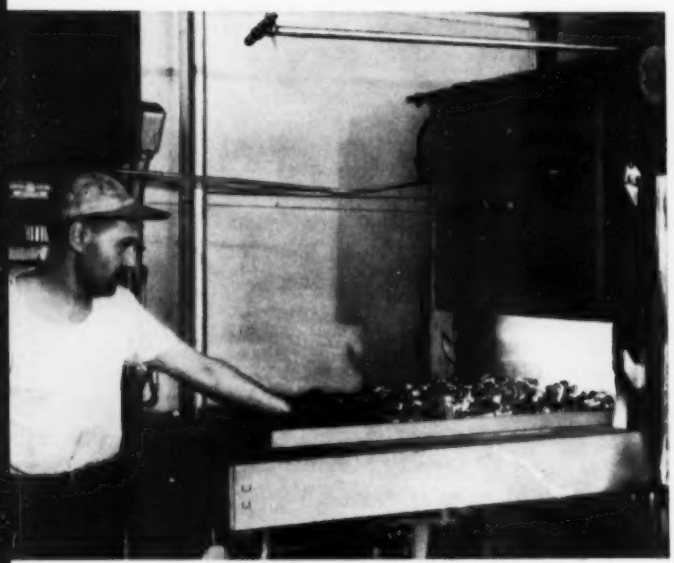
BROWN INSTRUMENTS

First in Controls



"GREAT ONE-MAN HEAT TREATER," is the way Greenman Steel describes this G-E box furnace with cooling chamber. Accurate control of the temperature is provided by the G-E control unit shown behind the furnace.

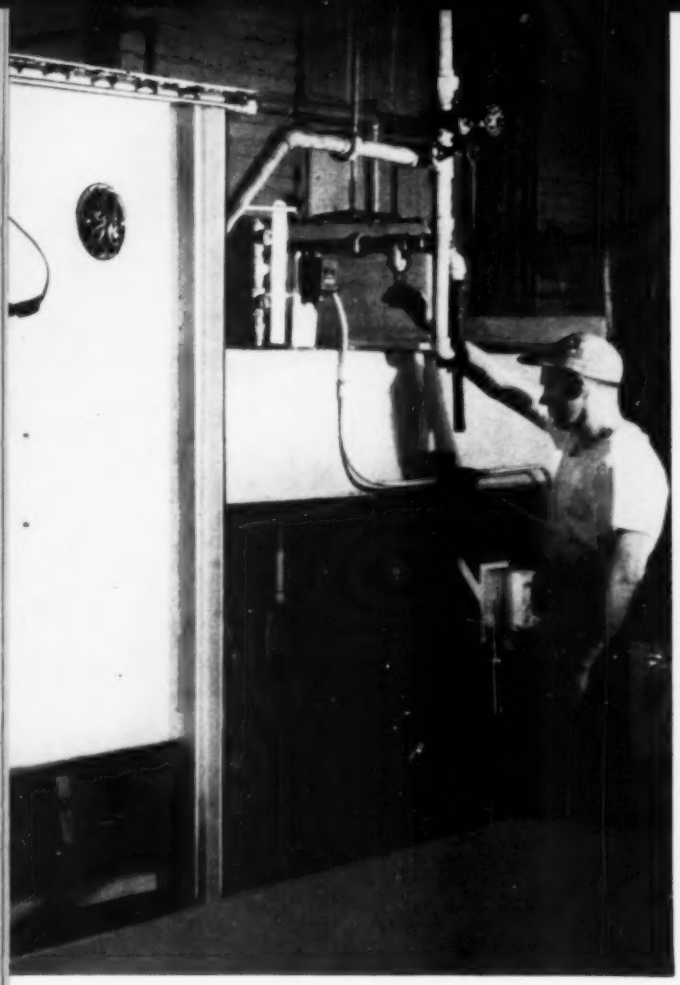
"Versatility of G-E Furnace Almost

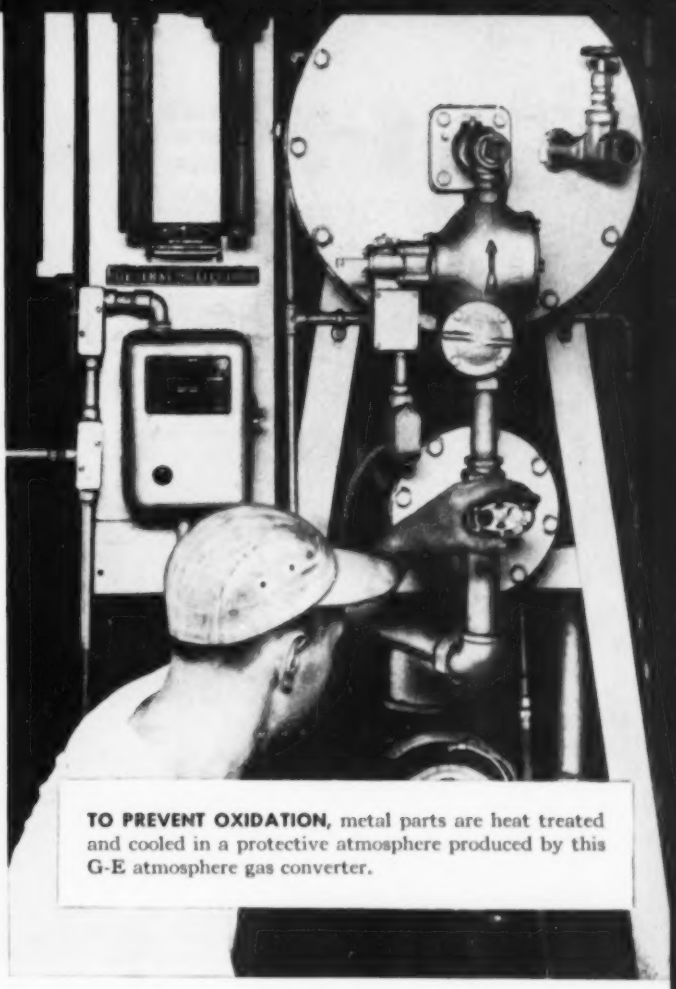


MANY HEAT-TREATING JOBS can be done with this one G-E box furnace. Greenman Steel uses it for copper brazing, silver brazing, annealing, and hardening. Here, the furnace is employed to anneal drawn-steel cups.



HIGH-QUALITY WORK is achieved by moving the parts directly from the furnace to the atmosphere cooling chamber, thereby minimizing oxidation. Here, the parts emerge from the cooling chamber clean and bright.





TO PREVENT OXIDATION, metal parts are heat treated and cooled in a protective atmosphere produced by this G-E atmosphere gas converter.

Unlimited," Says Industrial Heat Treater

Operational savings of G-E furnace keep Greenman Steel competitive

Heat-treating jobbers who demand versatility in a furnace find that General Electric's box furnace with water-jacketed cooling chamber is ideal for general-purpose work.

Says Lloyd G. Field, General Manager of Greenman Steel Treating Corp., Worcester, Mass.:

"As a heat-treating jobber, we have to produce high-quality work at lower cost than equipment manufacturers can do it themselves. We must be ready to handle all sorts of heat-treating jobs, yet our investment in equipment must be kept to a minimum. We find that our G-E box furnace satisfies all these requirements. It enables us to stay competitive because it produces superior work at low cost. It minimizes our equipment costs because its versatility is practically unlimited. We use it to copper braze, silver braze, anneal, and harden."

MANY SAVINGS, HIGH-QUALITY WORK

Mr. Field pointed out that operating costs are low because the insulating qualities of the furnace minimize heat loss. Automatic control of the heat assures him of high-quality work.

FOR APPLICATION HELP

Whether your operation demands a small-capacity, all-purpose furnace, or one that is engineered for a particular process and intended for high-production rates at the lowest possible cost, General Electric can satisfy your requirements. For application help from a G-E Heating Specialist, contact your G-E Apparatus Sales Office.

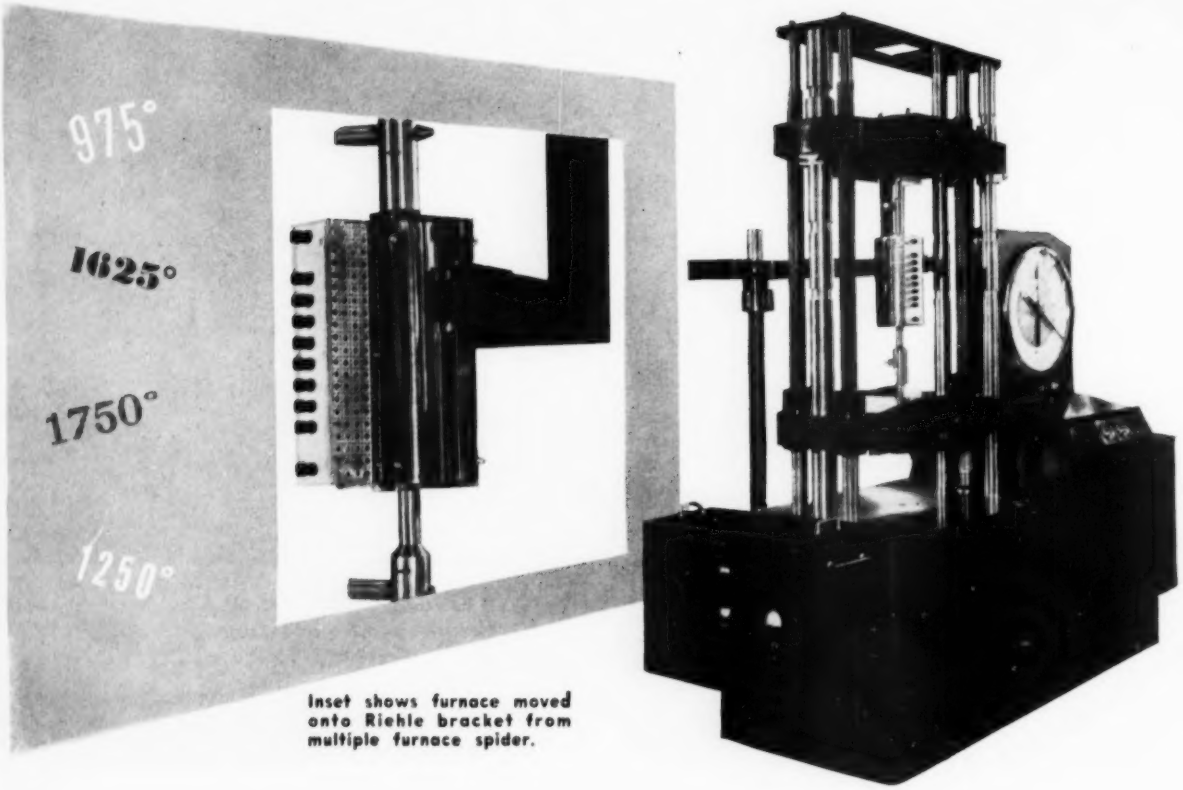
GENERAL ELECTRIC

WRITE NOW FOR THESE MODERN METAL PROCESSING BULLETINS

- Furnace and Induction Brazing, GEA-5889
- Annealing Malleable Iron, GEA-5797
- Forging with Induction Heat, GEA-5983
- Heat-treating Aluminum, GEA-5912

Address: General Electric Co., Section 720-129, Schenectady 5, N. Y.

THE HEAT'S ON



Inset shows furnace moved onto Riehle bracket from multiple furnace spider.

FOR HIGH TEMPERATURE TESTING

In many industries today, the search is for materials that will stand up under higher and higher temperatures.

If you want to predetermine the reaction of metal alloys during forming operations and in use at high temperatures, Riehle Screw Power Testing Machines will furnish the answers. Electric furnaces that heat specimens up to 1750° F. can be utilized. And, as many as 6 furnaces can be installed on one Riehle machine to speed up production testing.

This Riehle screw power machine assures positive control of testing speed. It is equipped with a self-compensating drive so the rate of strain can be maintained regardless of increases in load.

Riehle's 5-scale range feature ideally provides the coverage necessary to test specimens at elevated temperatures. Simplified specimen holders facilitate quick connection of the specimen after it is brought up to temperature.

For further details about high temperature testing with Riehle machines, mail coupon.

RIEHLE

TESTING MACHINES

Division of American Machine and Metals, Inc.
East Moline, Illinois

"One test is worth a thousand expert opinions"

RIEHLE TESTING MACHINES
Division of American Machine and Metals, Inc.
Dept. MP-754, East Moline, Illinois

Please send details on Riehle machines for high temperature testing.

COMPANY

ADDRESS

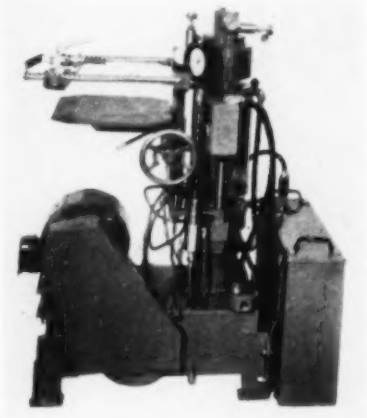
CITY ZONE STATE

NAME AND TITLE

engineering digest OF NEW PRODUCTS

Precision Casting

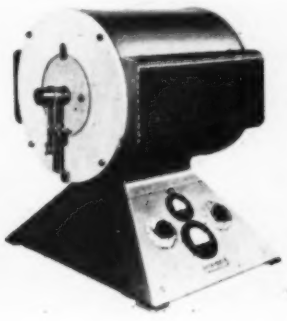
Alexander Saunders & Co. have announced a new wax injection press for pattern reproduction. The press has a pressure range to 1000 psi. and capacity up to 138 cu. in. Wax temperature is kept under separate thermostatic controls at the nozzle, in the pressure cylinder, and in the reserve cylinder holding tank. It uses a hydraulic pressure ram to force wax from a movable cylinder through an injection nozzle at controlled temperatures and pressure.



For further information circle No. 1 on literature request card on p. 32-B.

Combustion Tube Furnace

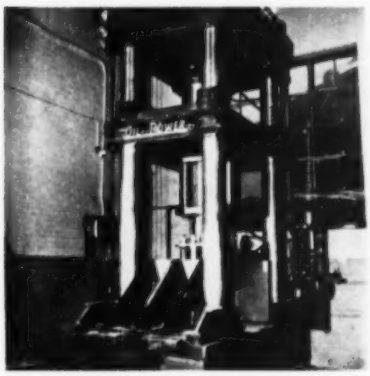
Hevi Duty Electric Co. has announced a new high temperature combustion tube furnace which operates at temperatures up to 2600° F., high enough for combustion of high alloy and heat resisting steels. The furnace is a complete self-contained compact unit with all the necessary temperature indicating and control devices located in the base. Combustion tubes of different diameters up to 2 in. can be used by changing inserts at the furnace ends.



For further information circle No. 2 on literature request card on p. 32-B.

Powder Metallurgy

The Oilpower Engineering Co. announces a new hydraulic press for compacting powdered metals. The press has a 1250-ton, double acting top ram, and a 900 ton double acting side ram. It can be used both for split die pressing of powders and titanium and zirconium sponge.



Of all welded steel construction, the press is of compact, self-contained design, requiring a floor area for both press and hydraulic power unit of only 8 x 10 ft. The press is 22 ft. high.

For further information circle No. 3 on literature request card on p. 32-B.

Alkaline Cleaner

Oakite Products, Inc., has announced a new alkaline-type cleaner for use in pressure-spray washing machines without objectionable foaming. Composition No. 161, is a white, free-flowing, powdered material that is soluble in water, free rinsing, and inhibited to provide safety to aluminum. Due to its anti-foam properties, this material is also effective in the new, high-pressure-spray washing machines for cleaning steel and other metals. It is used in pressure washing machines in the concentration of ½ to 2 oz. per gal., at temperatures ranging from 160 to 185° F.

For further information circle No. 4 on literature request card on p. 32-B.

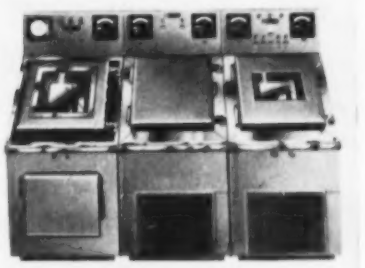
Microscope

E. Leitz has announced a new inclined binocular microscope combining coarse and fine focusing adjustments in one manipulating knob. The high power 4 mm. and oil immersion 2 mm. lenses supplied with this microscope have built-in protection devices to prevent damage to the front lenses. The microscope arm is a one-piece aluminum casting. The binocular body is fitted with a quick change bayonet mount and may be positioned to face forward or backward. An inclined monocular tube is also available.

For further information circle No. 5 on literature request card on p. 32-B.

Environmental Cabinets

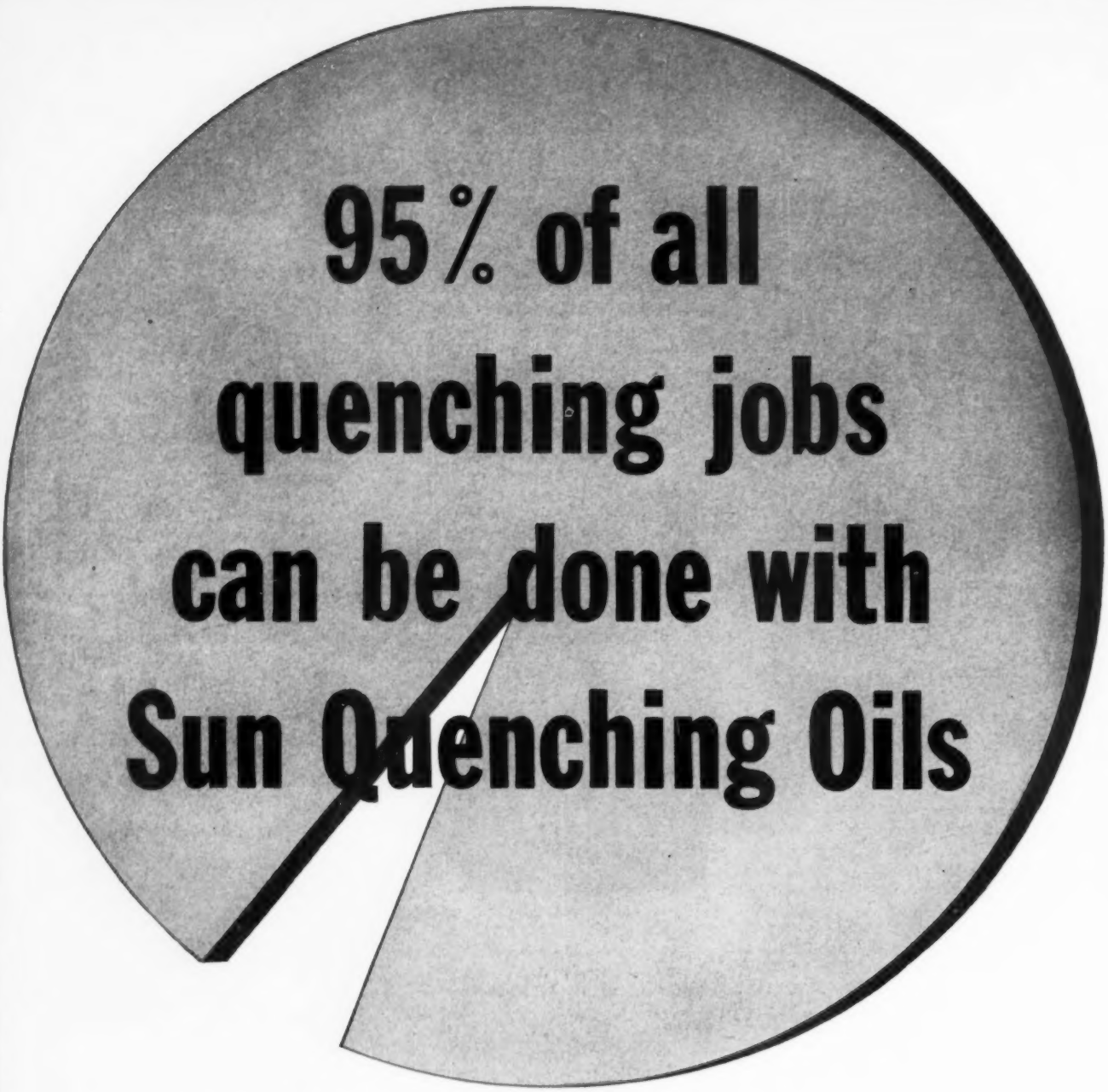
New environmental test cabinets recently introduced by Murphy & Miller feature a sloping front design. The new design permits faster loading, unloading and easier viewing, and is said to maintain more uniform test conditions. The cabinets are ready to plug into any 110 v. connection and are available to meet low temperature, humidity, fungus or high temperature requirements. The models illustrated have stainless test spaces of 2 cu. ft.



For further information circle No. 6 on literature request card on p. 32-B.

Recorder

A recording system capable of continuously logging conditions found in multiples of 48 to 144 points, at the rate of one point every 1 to 5 sec. has been developed by Minneapolis-Honeywell Regulator Co. The new multipoint logging system was designed for testing and research applications where a record of all measurements is required. It has a single set point and includes a strip chart recording instrument, a junction box



. . . AT MUCH LOWER COST

For 95% of your quenching jobs, you don't have to use expensive compounded oils. Sun's low-cost quenching oils will give the same uniform results, assure fast and thorough quenching, help increase production and lower maintenance. The booklet "Sun Quenching Oils" tells the complete story. For your copy, call your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MP 7.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

SUNOCO®

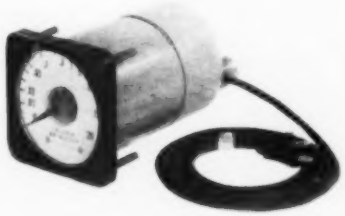
PHILADELPHIA 3, PA. • SUN OIL COMPANY LTD., TORONTO & MONTREAL

(functioning as the control center for the system) and up to three switch units. The multipoint logger may be stopped on any one point and utilized as an indicator, recording that point continuously. There are two types of systems—a 24-v. d-c. system and a 115-v., 60-cycle a-c. system. Special arrangements are available for some double range calibration.

For further information circle No. 7 on literature request card on p. 32-B.

Vacuum Gage

A new molecular vacuum gage designed to measure pressures without external detectors has been announced by General Electric Co. The



instrument is available in two types, one calibrated directly for dry air and the other for individual calibration; both covering the range of ½ micron to 20 mm. of dry air. Operation is based on the viscous interaction of the studied gas between a driven rotor and an armature which deflects the pointer against a spring force. The 3600-rpm. synchronous motor requires 120 volts at 60 cycles. The instrument weighs 5 lb. and measures 4-5/16 in. square by 5-7/8 in. deep for panel mounting.

For further information circle No. 8 on literature request card on p. 32-B.

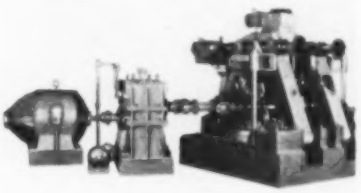
Electroplating Nickel

A process for applying nickel directly to aluminum, to afford an erosion-resistant surface and strengthen the aluminum, has been announced by the Bart Laboratories Co. The new electroplating process eliminates the need for an intermediate bonding material. Even very thin deposits of nickel over the aluminum provide an erosion, pitting, gouging and corrosion resistant surface. When deposited to both surfaces of aluminum sheets, the nickel deposit strengthens the aluminum without materially increasing the weight. Intricate designs and shapes, such as castings, can be given protection of both interior and exterior surfaces. The nickel-clad aluminum can be sheared, bent or fabricated, and it is not subject to separation at high temperatures. Hardness can be varied from 150 to 550 Vickers. Also, the nickel can be deposited with either compressive or tensile stress.

For further information circle No. 9 on literature request card on p. 32-B.

Straightening Machine

Sutton Engineering Co. has announced a new model in its line of guideless seven roll straightening machines. The new machine is designed for end-to-end straightening of 1¼ in. to 3¾ in. o.d. tubes and 1¼ to 3 in. diameter bars at high production



speeds. A cluster-roll arrangement is employed in the pass line. A three roll cluster, consisting of a large driven roll with two opposed idler rolls, is located at the entry end of the machine and another identical cluster is at the delivery end. In the clusters, rolls are positioned at approximately 120° to each other. Between the

Only RICHARDS thermocouple heads

GIVE YOU ALL THESE FEATURES . . .





- Thermocouple inspected in 20 seconds **WITHOUT DISCONNECTING LEADS** . . . saves time . . . no tools required . . . just unscrew cover and withdraw element . . . minimum interruption of production . . .no possibility of wrong re-connection.
- Thermocouple easily removed, then replaced if necessary merely by loosening only two screws.
- Screw cover design — with leads passing through cover so it can not be dropped or misplaced.
- Ductile metal parts are rust and corrosion resisting.

  #2158 CONNECTOR (included in above head, or used separately).
- Thermocouple wires enter connector **without bending** . . . saves time . . . permits use of small, economical protecting tubes.
- Designed for severe service . . . ceramic body withstands high temperatures indefinitely.
- Low cost. When ordering, specify #2150 head and thread on protecting tube.

ARKLAY S. RICHARDS CO. INC.

74 WINCHESTER ST., NEWTON HIGHLANDS 61, MASS.

• Thermocouples • Thermocouple Wire • Thermocouple Lead Wire • Insulators • Protecting Tubes • Pyrometers

THE CONTROL OF QUALITY IN MELTING AND CASTING

THE CONTROL OF QUALITY IN THE PRODUCTION OF WROUGHT NON-FERROUS METALS AND ALLOYS—I.

Cloth. 4to. 88 pages, with 14 plates and numerous illustrations in the text. Price $2.50, post free.

CONTENTS

The Principles of Technical Control in Metallurgical Manufacture.
By A. R. E. Singer, B.Sc., Ph.D. (*University of Birmingham*)

The Control of Quality in the Production of Brass Ingots and Billets.
By Maurice Cook, D.Sc., Ph.D., F.I.M. and C. L. M. Cowley, B.Sc., A.I.M. (*Imperial Chemical Industries, Ltd., Metals Division*)

The Control of Quality in Melting and Casting Copper and High-Conductivity Copper-Base Alloys.
By J. Sykes, F.I.M. (*Enfield Copper Refining Co., Ltd.*)

The Control of Quality in the Casting of Zinc and Zinc Alloy Rolling Slabs and Extrusion Billets.
By C. W. Roberts, B.Sc., A.I.M. and B. Walters, M.A. (*Imperial Smelting Corporation, Ltd.*)

The Control of Quality in the Melting and Casting of Aluminum Alloys for Working.
By R. T. Staples and H. J. Hurst (*T. I. Aluminum, Ltd.*)

The Control of Quality in Melting and Casting Magnesium Alloys for Hot Working.
By R. G. Wilkinson, B.Sc. and S. B. Hirst, B.Sc.Tech. (*Magnesium Elektron, Ltd.*)

General Discussion and Indexes.

INSTITUTE OF METALS
4 Grosvenor Gardens, • London, S.W.1

clusters is an unopposed pressure roll. Featured in the new straightener are automatic roll angle adjustments, with coordinated angling of all rolls, and power operated adjusting screws. Change-over for sizes usually takes less than 2 min.

For further information circle No. 10 on literature request card on p. 32-B.

Welding Positioner

A new bench-type welding positioner has been announced by the American Equipment Co. The positioner is engineered for downhand welding. It is designed for full-range movement of work, with speed adjustment under full control of the welder. Equipped with a gear-type fluid drive motor, it operates on 110 v., a-c., 60 cycle. A wide range of speeds is provided with extra low "creeping speed" for certain welding operations. Work up to 100 lb. or more may be handled. Table tilts to 135° vertical, tilting being done either by hand or by power.



For further information circle No. 11 on literature request card on p. 32-B.

Electropolisher

Electro-Glo Co. has announced a new electropolishing concentrate which operates at room temperature. The process, involving the use of Electro-Glo 200, is designed to level the surface, remove high spots and burrs, and produce finishes from satin to mirror-bright on copper and copper alloys. It will polish intricate shapes, increase corrosion resistance, and aid adhesion of plating. It provides a method of machining metal parts electrochemically to tolerances of 0.0001 in. The concentrate uses standard plating tanks and equipment. Metal is removed rather than deposited.

For further information circle No. 12 on literature request card on p. 32-B.

Polishing Desk

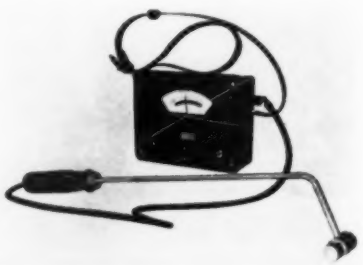
A new cabinet-type polishing table with companion storage cabinets for the production of metallurgical specimens has been announced by Buehler, Ltd. The two-unit polishing table has Formica top, and is approximately 60 in. long by 27 in. deep, and 30 in. high to table top. It includes two swing spouts, a large wash bowl with drain, plumbing and wiring. A storage cabinet with recessed light on supporting panel for installation above the polishing desk and a floor model storage cabinet are also available.



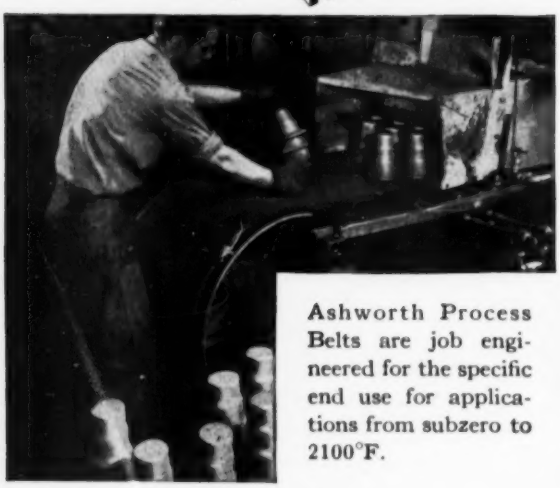
For further information circle No. 13 on literature request card on p. 32-B.

Tin Content Indicator

The redesigned Wheelco tin content indicator offers increased durability due to improvements in both the sens-



Metal Conveyor Belts
FOR
POWDER METALLURGY
BRIGHT ANNEALING
COPPER BRAZING
by ASHWORTH



Ashworth Process Belts are job engineered for the specific end use for applications from subzero to 2100°F.

WRITE FOR ILLUSTRATED CATALOG 52P

ASHWORTH BROS., INC.
METAL PRODUCTS DIV. • WORCESTER, MASS.

Sales Engineers: Buffalo • Chattanooga • Chicago • Cleveland • Detroit • Kansas City • Los Angeles • New York • Philadelphia • Pittsburgh • Rochester • Seattle • St Paul • Canadian Rep., PECKOVER'S LTD. - Toronto - Montreal

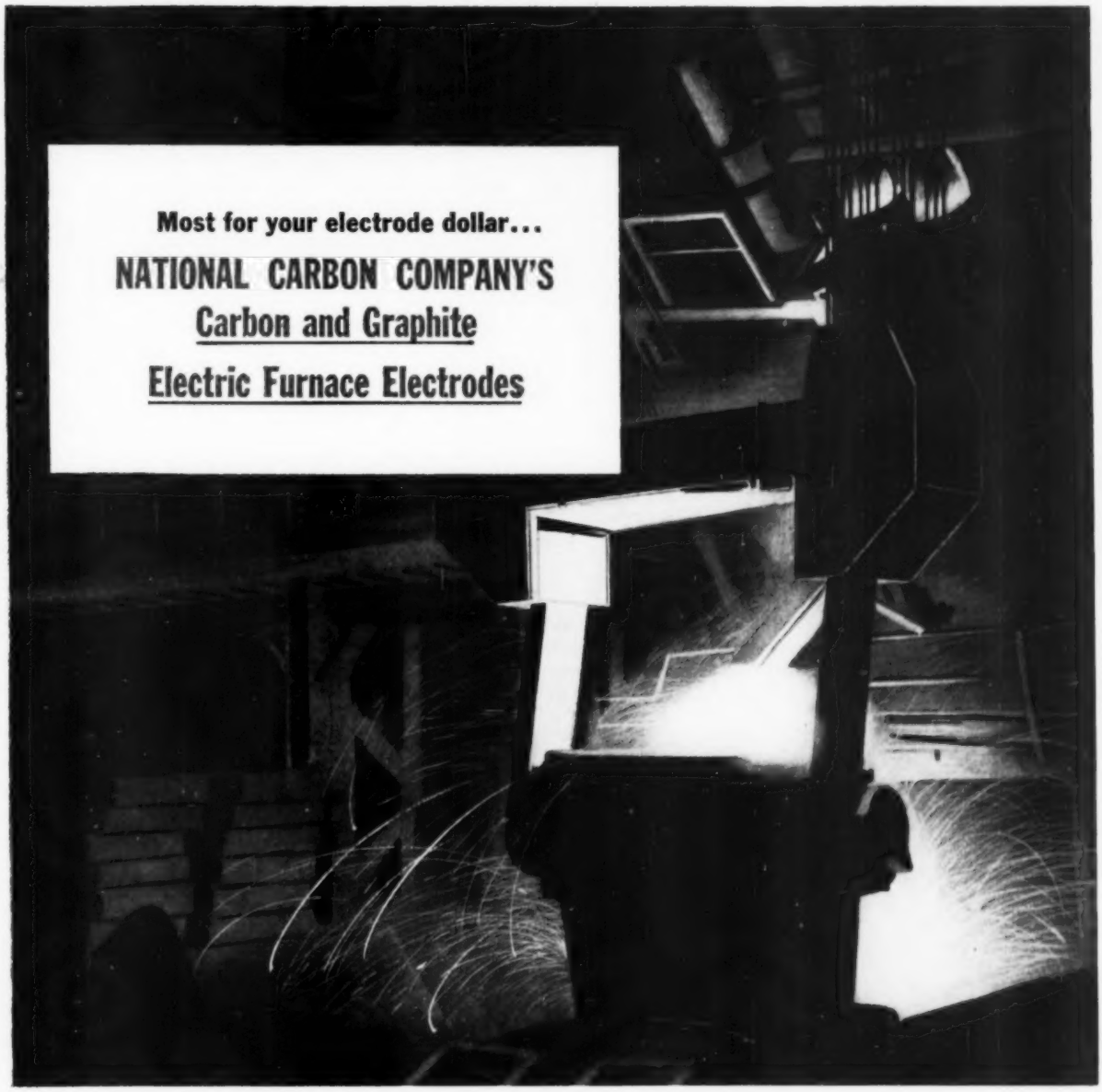
Revco
SUB-ZERO CHESTS
Temperatures as low as
-95° F
BELOW ZERO
•
For Shrink Fits
Seasoning Gauges
and Precision Tools
For Laboratory Tests
•



REVCO RIVET COOLER *Shown with 90 Rivet canisters*... Model RSZ-503
Special Equipment Added To Meet Customer Requirements, if desired.

MODEL	CU. FT.	TEMP. PULL DOWN 70° RM	CAPACITY Inside (") L	W	H	OUTSIDE Dimen. (") L	W	H	Hermetic UNITS*
RIVET COOLER RSZ-503	5.0	−30°	30	16	18	42	28	41	¼ HP
SUB-ZERO SZH-153	1.5	−95°	23	12½	9	42	28	43	¾ & ¼
SUB-ZERO SZH-653	6.5	−85°	47	16	15	60	28	43	¾ & ¼

*Fan Cooled; Refrigerant F22 and F12; Current 110/60 • WRITE TO:
REVCO INC.... DEERFIELD, MICH.



Specify National Carbon's Furnace Electrodes with complete confidence on two counts:

- **PRODUCT QUALITY, recognized to be the finest in the industry.**
- **ORGANIZED TECHNICAL SERVICE, functioning directly through our national sales force.**

Here are the two basic ingredients of electrode economy — proved *superiority of product and technical-service* organized specifically to help customers put this quality to work for greatest electrode economy. Repeatedly this service to the industry has recommended details of electrode operating practice, resulting in more efficient power utilization, better joints and joining procedure, and attractive electrode savings.

Take advantage of this specialized knowledge. Write or call National Carbon Company for complete details.

FOR ELECTRODES AND ELECTRODE SERVICE...
Rely on NATIONAL CARBON COMPANY!

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto

NATIONAL CARBON PRODUCTS

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS



HIGH ALLOY STEEL is being poured here from a 1000-lb. high-frequency induction furnace. It is lined with a Norton MAGNORITE* refractory cement which lasts 16% longer than the cement previously used.



CLOSE-UP OF THE SAME FURNACE, taken immediately after metal has been poured, shows how effectively this engineered-to-the-job Norton MAGNORITE cement resists mechanical and chemical attack.

How much more steel will you melt per lining *with Norton*

ENGINEERED Rx PRESCRIBED

MAGNORITE cements?

It's easy to find out how much longer Norton MAGNORITE refractory cement will last in your high-frequency furnaces than your present linings. Just call on the 40-year problem-solving experience of Norton Refractory Research which gave this satisfied customer (name on request) 16% longer lasting lining.

Whether you melt straight steel or heat-resistant compositions, you'll get a Norton MAGNORITE cement that's Engineered Rx Prescribed to fit your exact requirements. It will withstand temperatures up to 3250 F. if need be. It will have a high-rammed density that offers great resistance to metal penetration, erosion and chemical attack . . . and freedom from shrinkage cracks that often lead to furnace failure. Why not run a test on one of your furnaces soon?

Whatever your metal-melting problem, you can depend on Norton Research to help you. Working with MAGNORITE*, ALUNDUM*, CRYSTOLON* and FUSED STABILIZED ZIRCONIA cements and special shapes, Norton engineers are sure to come up with the right answer for you.

For full details about Norton Rx Refractories, contact your nearby NORTON refractories engineer, or write to NORTON COMPANY, 326 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

REFRACTORIES

ENGINEERED Rx PRESCRIBED

Making better products... to make other products better

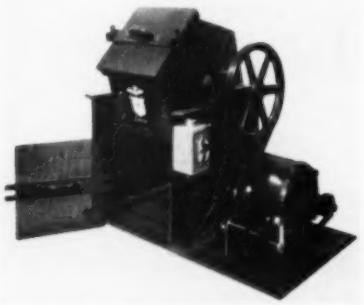
NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

ing unit head and the meter movement. This portable, direct reading indicator is used for quick analysis of the lead and tin contents in solder for process control. The tin content indicator will show the correct percentage of tin in the sample by measuring the difference in temperature at the transformation point of the lead standard and the lead-tin sample.

For further information circle No. 14 on literature request card on p. 32-B.

Tumbling Barrel

Lord Chemical Corp. has announced a new bench tumbling barrel. Built entirely of heavy gage steel, it occupies only 14 x 24 in. of bench space. The plastic lined, steel drum rotates on double shafts mounted on heavy channels carried by self-aligning ball bearings. This model is powered by

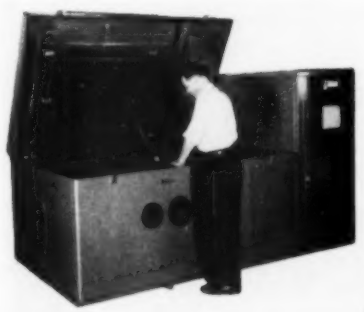


a ¼ hp. motor which operates on 110 volts at 60 cycles. It offers two different speed controls, one of approximately 19, 35 and 58 r.p.m., the other with speed variation from 0 to 65 r.p.m.

For further information circle No. 15 on literature request card on p. 32-B.

Test Chamber

A new industrial test chamber which can drop temperatures from + 600 to — 100° F in less than 2 hr. is now being produced by Conrad, Inc. The chamber was designed to simulate the temperature range of high-altitude sonic flight. The unit can also be used for treatment or tempering of tool or special steels. Temperatures can be held within 2° of any set point

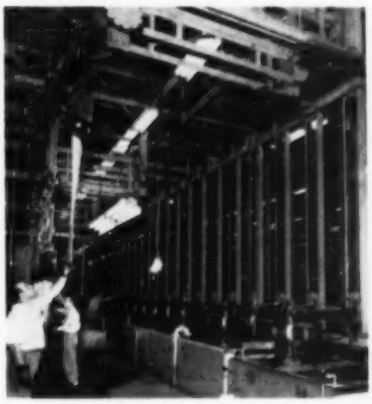


and can be increased or decreased within any range, and at any desired rate through automatic, recording controls. Top opening is provided for observation of parts or mechanisms under test. Powered devices can be operated in the chest, with controls and wires passing through front and side access ports. The fast drawdown of temperature is produced by the forced venting of the heated air, and at + 200° F the cooling unit takes over.

For further information circle No. 16 on literature request card on p. 32-B.

Plating Conveyor

A Hanson - Van Winkle - Munning elevator-type plating conveyor at Hamilton Standard Div. is zinc-plating big steel propeller blades 30 to 50% faster than a former manual handling system. Unusual feature of the operation is the automatic transfer of blades from and back to the plating conveyor. The transfer conveyor only picks up those blades that are supposed to be recycled. Other blades remain on the plating conveyor and are delivered to the unloading station. Controlling transfer to the monorail is a mechanical counter located on top of the blade-holding fixture. It engages a limit switch on the transfer conveyor. The counter is set for the proper number of recycles prior to

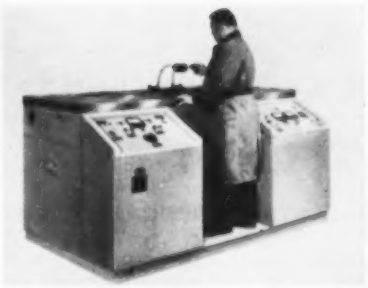


loading the blade on the conveyor. Blades are recycled up to six times. Plating thickness and number of recycles are determined after test balancing the blades. The conveyor has a lift of 10½ ft.

For further information circle No. 17 on literature request card on p. 32-B.

Induction Heating

A new design in high frequency induction heating equipment has been announced by Electric Arc, Inc. The units combine both current generator and work table in a single cabinet. Rated outputs are 10 or 20 kw. The



top of the generator provides a 33 x 100 in. work table which facilitates set-up and operation, making it convenient for production-line operation.

For further information circle No. 18 on literature request card on p. 32-B.

Zinc and Tin Gage

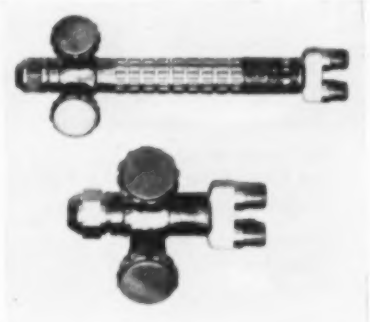
A new gage designed for production line measurement of the amount of tin and zinc plated on steel, either electrolytically or by the hot dip process, has been announced by Industrial Nucleonics Corp. The new model is a noncontacting, beta reflection gage providing control of top and bottom plate thickness and enabling differential plating. The basic components of the gage are a source of radiation, a radiation detector, and a recording console.

The unit traverses the width of the strip on precision-ground steel tubes. Designed for heavy industrial use, these twin steel support tubes are capable of spanning sheets up to 160 in. wide. To permit readings of edge-to-edge coating variations, an electrical servo system positions the measuring head across the strip.

For further information circle No. 19 on literature request card on p. 32-B.

Welding Torches

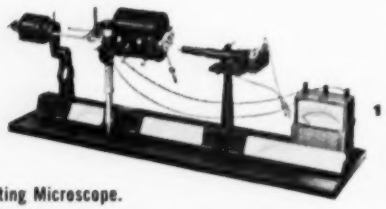
Air Reduction has announced two new welding torches. One is especially designed for light welding and brazing operations as on automobile bodies, airplane fuselages, kitchen utensils, metal furniture and other light fabrication and repair applications. It is 5¾ in. long and weighs 6 oz. A cutting attachment is avail-



LEITZ INSTRUMENTS

FOR THE

INDUSTRIAL LABORATORY

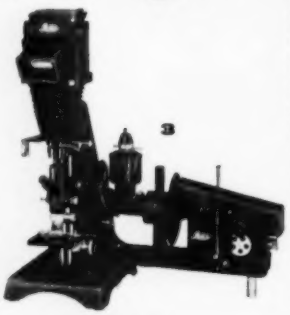


1. Leitz Heating Microscope. For determining the softening and melting behavior of fuel ashes, slags, glazes, enamels and ceramics.



2. Leitz High Power Binocular Magnifier. With magnifications up to 30x, interchangeable stands for observation in incident and transmitted light.

3. Leitz Panphot Metallographic Microscope. For research, photomicrography, photomacrography and for drawing and projecting micro-images.



4. Leitz Metallux Metallurgical Microscope. With exclusive quintuple nosepiece for magnifications of 50x, 100x, 200x, 500x and 1000x.



E. LEITZ, INC.

Distributor of the world-famous products of Ernst Leitz, Wetzlar, Germany

Leitz

microscopes
binoculars
Leica cameras
lenses

E. Leitz, Inc., *Dept. MP*

468 Fourth Avenue, New York 16, N. Y.

Please send me your brochure on the_____

*Name*_____

*Company*_____

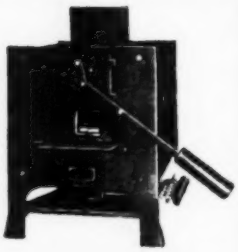
*Street*_____

*City*_____ *State*_____

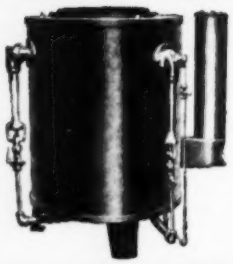
BUZZER HIGH SPEED *Gas* FURNACES

2400° F.
attained quickly with "BUZZER" High Speed Full Muffle Furnaces.

Designed primarily for high carbon and alloy steels.



NO BLOWER or POWER NECESSARY
. . . just connect to gas supply



"BUZZER" Atmospheric Pot Hardening Furnaces assure even heat up to 1650° F.

Used for Salt, Cyanide and Lead Hardening. Also adapted for Melting Aluminum.

Send for the complete "BUZZER" catalog today.

CHARLES A. HONES, INC.
123 South Grand Avenue, Baldwin, L. I., N. Y.

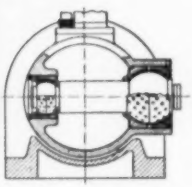


A CUSTOMER SPEAKS:

"Without our Optical Dividing Head, we would not even attempt to make the critical indexing work nowadays necessary for things that fly, or mechanism that must control angular motions to hit targets at a distance, to measure degrees, minutes and seconds, to eliminate angular velocity errors and vibrations in quick running mechanisms, etc."

The LEITZ Optical Dividing Head is the last word in indexing precision. Its construction is different from other optical and mechanical dividing heads on the market. A NEW DOUBLE SPHERICAL BALL BEARING, DOUBLE READING IN THE SAME EYEPIECE 180° APART, motor drive attachment and other features make the LEITZ an important aid required in any shop where precision is demanded.





The 2 spherical ends of the spindle are carried in hardened steel cups with several hundred small precision balls held in place by ball cages in such a way that each ball creates its own path. There is no play, either radially or axially, no oil film, no wear and a very large load capacity.

Write for Descriptive Bulletin

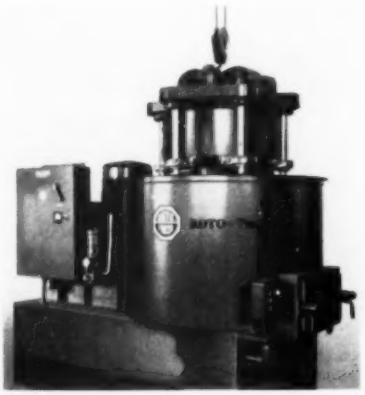
Geo. SCHERR OPTICAL TOOLS, Inc.
200 PG LAFAYETTE STREET • NEW YORK 12, N. Y.

able. The other unit is intended primarily for oxyacetylene burning or welding of lead products. This torch weighs 5 oz. and is 2½ in. long.

For further information circle No. 20 on literature request card on p. 32-B.

Barrel Finishing

Roto Finish has announced a new barrel finishing machine in which fixtured parts are oscillated through an abrasive media that remains relatively still. This machine is best suited for finishing parts which are too large to be handled by the conventional cylinder type machines. It has been used for finishing stampings, forgings and castings such as jet engine compressor and turbine blades, and flame deflectors. Fine finishes have been obtained on zinc die castings. Parts must be rigidly fixtured during the finishing operation. For this reason the design of the parts should be such that



they can adequately resist the rather heavy pressures created by the action of forcing the fixtured parts through the processing media. The machine is adaptable to either dry or wet processing, depending on the kind of part and the result to be produced.

For further information circle No. 21 on literature request card on p. 32-B.

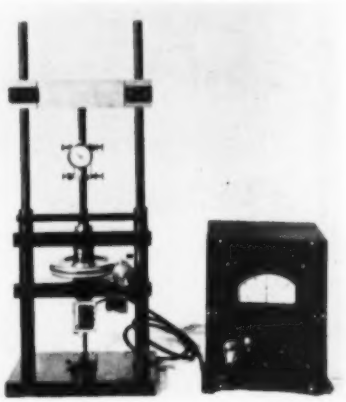
Steel Powder

Vanadium-Alloys Steel Co. has announced the development of a new prealloyed steel powder for high strength powder metallurgy applications. Improvements in the 4650-A steel powder will enable fabricators to produce high strength parts by briquetting and sintering without resorting to secondary treatments any more elaborate than simple hardening. Improvement in the toughness and hardenability of 4650-A powder parts will permit the manufacture of gears and other high strength, high production parts. Produced to A.I.S.I. 4650 chemistry, VASCO 4650-A has excellent green strength and is moldable at low pressures to yield dense, strong compacts. It is basically a nickel, molybdenum composition, available with various carbon contents.

For further information circle No. 22 on literature request card on p. 32-B.

Portable Comparator

For calibrating extensometers, compressometers, dial gages and similar instruments Baldwin-Lima-Hamilton Corp. has announced a new exten-



someter comparator. The instrument is of small size and is portable. It eliminates mechanical linkages as a source of error by use of a miniature variable transformer and null balance indicator to apply small displacements to extensometers with an accuracy within 0.00001 in. for calibration. Extensometers having gage lengths up to 10 in. and ranges up to 0.250 in. can be checked by means of this comparator. Standard equipment includes adapters for extensometers used on 0.252-in., 0.357-in. and 0.505-in. diameter rounds.

For further information circle No. 23 on literature request card on p. 32-B.

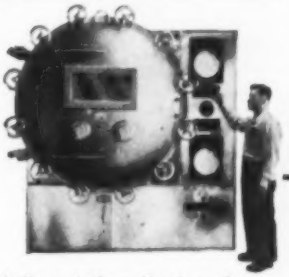
Nonferrous Finishes

Allied Research Products, Inc., has announced the development of five new protective coatings for zinc, silver, copper and aluminum. Two Iridites provide bright, decorative and protective finishes directly on zinc die castings. The resultant finish can be used as a preparation for electroplated finishes by chemically removing the protective film. Another finish provides good tarnish resistance for industrial silver plate without substantially changing the appearance of the silver. A fourth new process provides greater corrosion resistance and paint adherence for copper and copper alloy surfaces. The basic coating resembles the base metal in appearance and can be dyed yellow, red, orange or green for color identification purposes. The fifth process is for alu-

WEBBER

TRADE MARK REGISTERED

Environmental Test Chamber



Simulates Atmospheric Conditions to 100,000 ft.

Prototype unit designed and built to rigid specifications of a large electrical components manufacturer. Inside test chamber is 36" square. Temperature range from −100° F. to +250° F. 20% - 95% humidity range at temperatures of +35° F. to +185° F. Assimulates 100,000 ft. atmospheric pressure in ten minutes. Completes temperature change from +250° F. to −100° F. in 45 minutes. Heat cycle uses hermetically sealed moisture proof—low density electrical elements. Chamber is equipped with electrical terminals for connection to components inside the chamber. Exclusive feature permits accurate altitude, temperature and humidity control.

Insulated with moisture proof, light weight Foamglas. Full opening, free swinging door with multipaned tempered glass hermetically bonded to stand maximum temperatures and pressures.

Other models are available from 1 cubic foot, temperatures to −200 F. and altitudes to 500,000 ft.

WEBBER designs, engineers and constructs units to meet special and all requirements.

Write for more complete information.

INDUSTRIAL FREEZER DIVISION

WEBBER MANUFACTURING COMPANY, INC

Formerly Webber Appliance Co., Inc.

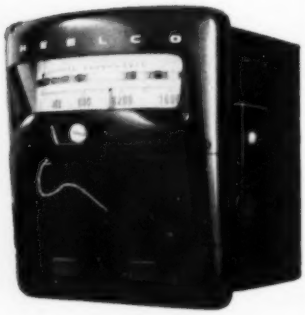
2747 MADISON AVENUE - INDIANAPOLIS 3, INDIANA

BARBER COLMAN

Wheelco Controllers

New Model 400

Streamlined and compact, with five forms of control and many advance-designed features. Available this summer.





Model 252P

For applications requiring flush-mounting of multiple-controller units.

...today's finest instruments, for low-cost temperature control!

Choose Capacitrols for the right control system on your furnaces, ovens, and kilns. These fine instruments give you important *extra values* — more flexible control . . . easier servicing . . . and lower maintenance costs — along with "top" accuracy. You get dependable, uniform heating because Wheelco's "no contact" principle speeds control action. Simplified unit construction eliminates maintenance, and keeps your equipment operating longer. And you can select the right control system — two-position, time-proportioning, multi-position, portional positioning or output-proportioning control — for best over-all results. Write for Bulletins F-5345 and F-6314

WHEELCO INSTRUMENTS DIVISION

BARBER-COLMAN COMPANY, DEPT. G, 1518 ROCK ST., ROCKFORD, ILLINOIS

Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

minum. Finish can range from yellow-iridescent to a uniform deep brown or can be bleached to produce a clear film. The five new products are applied by a simple chemical dip.

For further information circle No. 24 on literature request card on p. 32-B.

Torsion Testing

Machines for twist-testing parts, assemblies, sample stock and wire have been announced by Riehle Test-



ing Machines Div. These torsion testers can apply and weigh load in either direction of rotation. Indicating unit follows dimensional changes of specimen as load is applied, so no additional forces are set up during test. Five scale ranges assure precise load reading. Capacities range from 4000 to 300,000 in. lb.

For further information circle No. 25 on literature request card on p. 32-B.

Brazing Washers

Washers edgewound from flat wire in the notch coil form have been announced by Lucas-Milhaupt Engineering Co. They are produced without dies from standard wire stocks. Flat alloy wire is wound on edge and then cut partially through. The coil of washers is then shipped intact. When used, each washer is snapped from the



coil and preplaced on work as needed. Unused washers remain in coil form. Edgewound washers are suitable for use with induction, gas-air, furnace, or any of the commonly used heating methods. They are available in diameters up to 4 in., in thicknesses from 0.010 upward and in Easy Flo and Silfos as well as copper, bronze and the more commonly used alloys.

For further information circle No. 26 on literature request card on p. 32-B.

WHAT'S NEW

IN MANUFACTURERS' LITERATURE

40. Abrasive Wheels
Operating suggestions and recommended wheels for finishing stainless. *Manhattan Rubber Div.*

41. Alloy Chain
Bulletin No. 2 gives engineering data on three types of cast alloy chain—35% Ni, 15% Cr; 25% Cr, 12% Ni; and 65% Ni, 15% Cr. *Standard Alloy*

42. Alloy Hearth
Bulletin 112 on cast Ni-Cr hearth for heat treating furnaces. *Fahralloy*

43. Alloy Specifications
Charts of chemistry, properties, specification designations of copper and aluminum alloys and babbitts. *Lavin*

44. Alloy Steel
Data book on the selection of the proper alloy steel grades for each manufacturer's needs. *Wheelock, Lovejoy*

45. Alloy Steel
32-page book on abrasion resisting steel. Properties, fabricating characteristics, uses. *U. S. Steel*

46. Alloy Steel
16-page book on Type 9115 low-alloy high-strength steel. Properties, fabrication, welding. *Great Lakes Steel*

47. Aluminum Coating
Article on hot dip coating of ferrous metals with aluminum and aluminum alloys from "Tips and Trends". *Ajax Electric*

48. Aluminum Die Castings
Bulletin on design and manufacture of aluminum die castings. *Hoover Co.*

49. Aluminum Extrusions
28-page book on extruded aluminum products. Design, tolerances, applications. *Revere*

50. Aluminum Forgings
Booklet describes facilities for aluminum extrusion and forging. *Bridgeport Brass*

51. Aluminum Heat Treating
8-page Bulletin 5912 on solution heat treating, annealing, stabilizing and aging of aluminum. *General Electric*

52. Ammonia Dissociators
Bulletin on dissociating process gives advantages of ammonia as controlled atmosphere. *Sargeant & Wilbur*

53. Anodizing
Data on aluminum racks with copper hooks for anodizing. *National Rack*

54. Architectural Aluminum
16-page booklet on aluminum products for architectural use, aluminum structural shapes, embossed finishes on aluminum. *Reynolds Metals*

55. Atmosphere Furnaces
Information on mechanized batch-type atmosphere furnaces for gas cyaniding, gas carburizing, clean hardening or carbon restoration. *Dow Furnace*

56. Atmosphere Furnace
Bulletin on controlled atmosphere furnace. *Industrial Heating Equipment*

57. Atmospheres
Bulletin 1-10 supplies technical information on inert gas generators and data on costs. *C. M. Kemp Mfg.*

58. Bar and Tube Turners
16-page bulletin on centerless turners for round bars and tubes. *Medart*

59. Basic Materials
24-page booklet on Alundum, Crystolon, Magnorite, Norbide, zirconia, carbides, borides and other basic materials. Products made from them are listed. *Norton*

64. Black Oxide Coatings
Data on black oxide coatings for steel, stainless steel and copper alloys. *Du-Lite*

65. Black Oxide Finish
Folder on penetrating black finish for ferrous metal. *Puritan Mfg.*

66. Blackening Stainless
Bulletin on process for blackening stainless steels, cast and malleable irons. *Mitchell-Bradford*

67. Blast Cleaning
6-page booklet on pressure blasting process and its applications in the field of deburring, cleaning, scale removal. *Cro-Plate Co.*

68. Boron Additive
6-page article on use of grainal as boron-additive alloy and properties of grainal steels. *Vanadium Corp.*

69. Brass
80-page book on properties and uses of brass forgings, sand castings, rods and machinings. *Mueller Brass*

---

39. Alloy Steel*

"Alloy Steel Pays Off" is an attractive 208-page, paper-bound book containing examples where alloy steel (including stainless) was used to advantage. It is prefaced by a 29-page general discussion of the increased use of alloy steels, net tons used by different markets and general advantages of alloy steels. Corrosion resistance, fabrication costs, strength, toughness and wear resistance are summarized.

Case histories cover 60 applications, such as bolts, chipper and hog knives, cultivators, hollow drill rod, sling chain, fencing, low-horsepower diesel engines and many others. The use of alloy steel in power shovels, for instance, begins with an explanation of the increased pay loads, reliability and ruggedness of a modern shovel made of alloy steels. Tables list parts made of alloy steel, the steels used and their properties.

The use of alloy steels in truck and trailer bodies and frames is discussed. While highly stressed truck parts have long been made of alloy steels, they are now being used for bodies because



of the weight saving and therefore increased pay load. Percent of weight saved and profit are tabulated.

A further case study tells of the high-temperature, pressure and corrosive conditions to which pressure vessels are subjected and compares carbon and alloy steels as possible alternatives in their construction.

*Published by the Climax Molybdenum Co. Copies are available at no charge to readers of *Metal Progress* who circle No. 39 on the request card, page 32B.

---

60. Bending
24-page article on in-plane bending properties of welding elbows. *Taylor Forge & Pipe Works*

61. Bending and Cutting
Folder describes hand and air-operated bender-cutter and its applications. *J. A. Richards*

62. Beryllium Copper
Bulletin 1 on available alloys, conditions, tempers and tables of sizes and properties. *Penn Precision Products*

63. Beryllium Copper
16-page booklet on applications and properties of beryllium copper. *Beryllium Corp.*

70. Brazed Tubing
12-page data book on brazed tubing made from copper coated steel. *Bundy*

71. Brinell Machine
Data on semi-automatic Brinell testing machine. *Detroit Testing Machine*

72. Buffing and Polishing
Brochure on facilities for production buffing, polishing and deburring. *Am. Buffing and Polishing*

73. Burners
16-page bulletin on selection of gas burners. *Western Products*

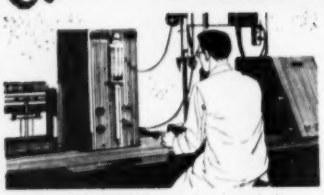
74. Calibrating System
Data on weighing and calibrating sys-

Need pounds or tons of

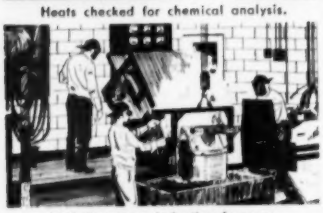


Custom-made Alloys for remelt or reprocessing?

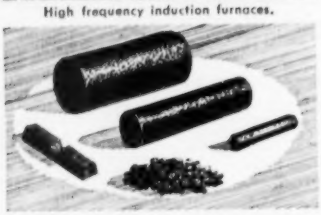
Call on Cannon-Muskegon



Heats checked for chemical analysis.



High frequency induction furnaces.



Carried in stock are supplies of the 300 and 400 stainless steels as well as carbon alloys. "Specials" including electronic and aeronautical type alloys, tool steels, ferritic, austenitic and super stainless alloys of nickel- and cobalt-base. Available in shot, ingot, billet or cast bars.

Exactly predictable metallurgical control of finished casting is assured by MasterMet control of high-temp alloys, tool, stainless, and carbon steels

You specify the alloy — we'll tailor it to your needs, backed by a *certified* analysis! Name the quantity and the fast delivery will surprise you! Preparation can begin almost immediately after receipt of order. MasterMet "alloy tailoring" gives you all this:

MATCHED ALLOYS TO YOUR MELTING PROGRAM — Close control assures a constantly uniform melt. The results you get from a sample cast are the same as the final production run.

MASTERMET CERTIFIED ANALYSIS — Regularly furnished are notarized certificates insuring alloys that will cast to your exact production specifications.

PRODUCTION MELTS OR SAMPLE JOBS — A combination of test furnaces and larger multiple production furnaces assure completely flexible service at any time.

FAST ACTION ON YOUR ORDERS — No long delays for a mill run. Alloys delivered in drums, clearly marked with all specifications for fast selection and storage.



Write today for your copy of new MasterMet Alloy Bulletin for complete technical details.

Cannon Muskegon CORPORATION
MASTERMET
2879 Lincoln Street • Muskegon, Michigan

METALLURGICAL SPECIALISTS

tem for accurate measurement of mechanical forces. *Morehouse Machine*

75. Carbide Coatings
12-page Bulletin 8065, "Flame Plating", on method of applying tungsten carbide coatings. Comparative wear test data. Applications. *Linde*

76. Carbon and Graphite
20-page catalog on carbon and graphite applications in metallurgical, electrical, chemical, process fields. *National Carbon*

77. Carbon Control
Catalog T-623 describes the Microcarb control system that continuously measures the active carbon in the furnace atmosphere during heat treatment. *Leeds & Northrup*

78. Carbonitriding
Bulletin 241 on gas-fired radiant-tube furnace for carbonitriding and other heat treating. *Lindberg Engineering*

79. Carburizing
16-page bulletin SC-134 reviews gas carburizing techniques and possibilities. *Surface Combustion*

80. Cast Bronze
24-page booklet on cast bronze and copper products gives research, process, engineering and production facilities and includes an alloy chart of principal alloys. *National Bearing Div.*

81. Centrifugal Castings
Booklet on spun centrifugal castings of bronze for liners, rings, rolls, sleeves, bushings. *American Non-Gran Bronze*

82. Ceramic Coatings
New brochure on ceramic coatings for protecting metals from heat and corrosion. *Solar Aircraft Co.*

83. Chromate Coatings
Folder gives characteristics and uses of chromate conversion coatings on nonferrous metals. *Allied Research*

84. Chromate Finish
Selection chart for chromate treatments for various metals and alloys. *United Chromium*

85. Cleaner
Folder gives data on metal cleaners for use with water in still-tank or spray-washing equipment. *Solventol*

86. Cleaning
Data sheets on acid activators to promote removal of scale and oxides from steel and iron. *Swift Ind. Chem.*

87. Cleaning
44-page booklet, "Some Good Things to Know About Metal Cleaning," discusses tank, barrel and machine cleaning, pickling, zinc phosphate coating, rust prevention and other processes. *Oakite*

88. Cleaning
How to operate your power washer at maximum efficiency. *Metalwash Mach.*

89. Cleaning Stainless
8-page booklet on care and cleaning of stainless steels. *Republic Steel*

90. Clad Metals
24-page booklet on principles of bonding, characteristics of clad metals, methods of cladding, uses. *Superior Steel*

91. Clad Wire
Booklet on properties of nickel-clad copper wire for conductivity use at high temperature. *Sylvania Electric*

92. Cold Finished Bars
Catalog of carbon and alloy steel bars. *Monarch Steel*

93. Cold Finished Steel
8-page bulletin on selection, use, relative cost of cold finished carbon steel bars. *Ryerson*



INCREASED TOOL LIFE... FINER FINISH...HIGHER CUTTING SPEEDS ...LESS REJECTS

METAL WORKING PLANTS GET GREATER PRODUCTION AT LOWER COSTS with...

SAFCO Cutting Fluids

TAILOR-MADE CUTTING FLUIDS TO FIT YOUR NEEDS.

In the comprehensive SAFCO line, there is a correct cutting oil or coolant especially designed for each type of metal and machining operation. This specialized selection makes it possible for our experienced sales engineers to help you choose the right cutting fluid for your particular job. *WRITE FOR FREE LITERATURE—TODAY!*

OIL PIONEERS FOR OVER 100 YEARS

SWAN-FINCH OIL CORPORATION

205 EAST 42nd STREET • NEW YORK 17, N. Y.

BUFFALO • CHICAGO • DETROIT • MEMPHIS

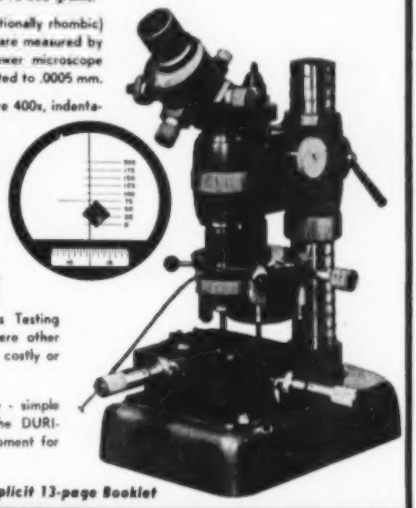
ADVANCE IN HARDNESS TESTING with the NEW DURIMET HARDNESS TESTER

Even the most delicate and highly finished parts or tools may be tested for hardness WITHOUT DAMAGING or DEFORMING THE FINEST FINISH.

The diamond impressions (invisible to the naked eye) are produced with loads of only 15 to 300 grams.

The pyramid (or optionally rhombic) shaped impressions are measured by means of a 400-power microscope with reticule graduated to .0005 mm.

Microscope objective 400x, indentator as well as an extra 100x locating objective are mounted on a common revolving turret for quick indexing on the impression.



The DURIMET opens up a NEW FIELD of Hardness Testing for every shop where other methods prove too costly or unsuitable.

A reasonable price - simple operation, make the DURIMET essential equipment for any shop.

Write for our explicit 13-page Booklet

Geo. SCHERR OPTICAL TOOLS, Inc.

200 PGH LAFAYETTE STREET • NEW YORK 12, N. Y.



"...and Pass the Ammunition!"

Naval Shells Heat Treated in PYRASTEEL Tubes

50 TONS of PYRASTEEL TUBES



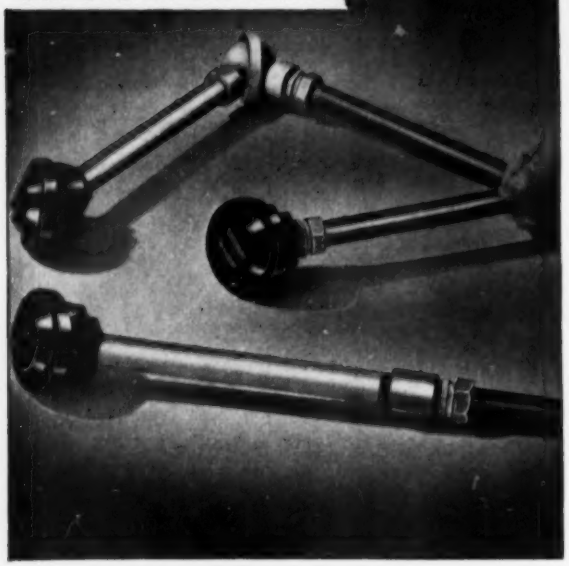
Write for PYRASTEEL Bulletin

Makers of ALLOY STEEL for over 45 Years

Six-inch shells are inserted in these PYRASTEEL bell-joint tubes. Then the tubes are placed end to end, forming long lines through which are pushed the shells at the proper heat treating temperature, which is proved to be rapid and economical. Just another of the multitude of uses of PYRASTEEL for high temperature applications.

CHICAGO STEEL FOUNDRY CO. Kedzie Ave. & 37th St., Chicago 32, Illinois

WHAT'S NEW AT BRISTOL...



Now... Bristol thermocouples with metal-ceramic protecting tubes

Bristol's new metal-ceramic LT-1 protecting tubes are the most important advance in thermocouple technology in years.

Combining the thermal conductivity and shock resistance of metal with the corrosion and oxidation resistance of ceramic materials, the new protecting tubes will last far longer than ordinary tubes, give you closer control and faster response.

Here are the advantages of the metal-ceramic LT-1's

- Resistance to combustion gases at temperatures up to 3100°F
- Resistance to oxidation in air at temperatures up to 2200°F
- Retention of strength at high temperatures – 1800 to 2500°F
- Greatly superior to most ceramics in resistance to thermal shock
- Resistance to attack by molten metals and furnace slag
- Increased sensitivity – the ⅛ inch wall has a high thermal conductivity

Get the whole story on Bristol's new tubes. Write for Bulletin P1261 today. The Bristol Company, 106 Bristol Road, Waterbury, Conn.

4.19

BRISTOL

Points the Way in Human-Engineered Instrumentation

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Special Metal Fabrications to Your Specifications!

Allied can supply your requirements for any special metal assembly for use in processing or manufacturing!

- TRAYS
- RACKS
- TANKS
- FIXTURES
- RETORTS
- MUFFLES
- CRATES
- BASKETS
- SPECIALTIES

Our modern, up-to-date facilities are equipped to fabricate practically any type of special assembly. Look at this list of precision-built products . . . recognize some of them? We can build these and many others to your specifications . . . from your prints . . . or, we will develop working prints for you.

Write TODAY! **... Let us help you solve your problem. Free literature on request!**

AMS *Allied*

METAL SPECIALTIES, INC.

1505 ROLAND HEIGHTS AVENUE

HAMPDEN STATION • BALTIMORE 11, MD.

A Few Choice Distributorships Still Available!

94. Cold Rolled Steels
32-page booklet on stainless, alloy and carbon spring steels, and other specialties. Melting, temper, finishes. *Crucible*

95. Combustion Control
Folder on mechanical drafting and an air-powered ejector. *Morgan Construction*

96. Continuous-Cast Brass
New bulletin on chemistry, sizes, advantages and applications of continuous-cast brass bars. *Scovill Mfg.*

97. Controlled Atmospheres
Bulletin 753 on generator for atmospheres for hardening, brazing, sintering and annealing carbon steels. *Hevi Duty*

98. Controller
Bulletin F-6314 on new model of capacitrols with four modes of control. *Wheelco*

99. Copper Alloys
New technical data book on phosphor bronze and nickel silver. *Seymour Mfg.*

100. Core Dryer
12-page bulletin on Foundromatic core dryer and how such drying fits existing setups. *Allis-Chalmers*

101. Corrosion Resistant Alloy
20-page booklet on nickel, chromium, molybdenum, iron alloy gives chemical composition, corrosion data, properties, welding characteristics. *Haynes Stellite*

102. Corrosion Resistant Coating
Bulletin No. 100 lists, classifies and gives further references to corrosion resistant coatings for numerous purposes. *Carboline*

103. Creep Testing
Bulletin 4208 on five types of creep testing machines for standard sized metal specimens. *Baldwin-Lima-Hamilton*

104. Cutting and Grinding
44-page booklet on cutting and grinding procedures. Charts and graphs of recommended concentrations for different metals and operations. *Master Chemical Corp.*

105. Cutting Fluid
Data on nonflammable, nonexplosive chemical for tapping, pipe threading, drill press work, lathe cutting. *Easy-Cut Mfg.*

106. Cutting Fluids
Folder lists types of cutting fluids and their specific applications. *Swan-Finch*

107. Cutting Oil
Facts on more efficient and economical plant operation through use of right lubricants described in "Metal Cutting Fluids" booklet. *Cities Service*

108. Cutting Oil Chart
Selection chart for seven classes of metal in nine machining operations. *Aldridge Industrial Oils*

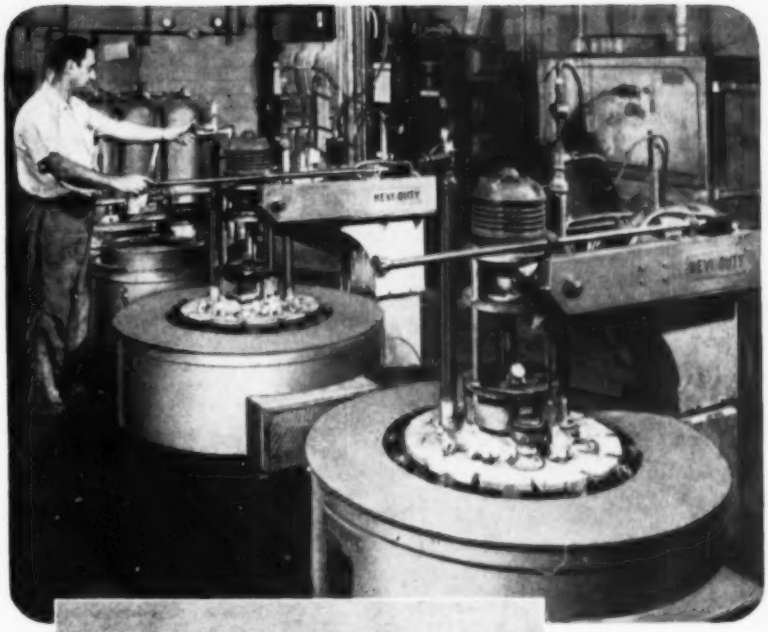
109. Deep Drawing
Reprint on new deep drawing technique involving single-stroke dies and eliminating intermediate operations. *Schnell Tool & Die*

110. Descaling Stainless Steel
Bulletin 25 on descaling stainless steel and other metals in molten salt. *Hooker Electrochemical*

111. Dew Point Control
Bulletin No. 21-C on instrument which indicates, records and controls dew point automatically. *Ipsen*

112. Diamond Abrasive
4-page folder on the advantages of diamond abrasives for polishing metallurgical specimens. *Buehler, Ltd.*

113. Die Steel
Data on air hardening, free machining die steel. *Latrobe Steel*





Typical parts heat treated in Hevi Duty furnaces at the Union Special Machine Co.

UNION SPECIAL
heat treats **precision parts in**
HEVI DUTY FURNACES

● Over 100 different heat treating operations are represented in one Union Special industrial sewing machine. All the carburizing, dry cyaniding and bright annealing of precision ground shafts, bearings, journals, castings and eccentrics is done in versatile Hevi Duty Vertical Retort Furnaces.

Walter Weinwurm, chief metallurgist at Union Special, says "Our Hevi Duty furnaces do an exceptionally good job of heat treating precision parts. The work comes out of the furnaces clean with no scale or oxidation."

Learn more about Hevi Duty vertical retort furnaces — write for your copy of bulletin HD-646 today.

HEVI DUTY

HEVI DUTY ELECTRIC COMPANY
MILWAUKEE 1, WISCONSIN
Heat Treating Furnaces... Electric Exclusively
Dry Type Transformers *Constant Current Regulators*

THER-MONIC

. . . the most complete line of INDUCTION, DIELECTRIC & FOUNDRY CORE BAKING EQUIPMENT

RENTAL PLANS also available! *Write for details!*



THER-MONIC
MOTOR GENERATORS are available with capacities up to 250 KW

High Frequency Heating by cutting production costs, enables you to pace today's competition! Use it to braze, solder, harden, anneal, forge or melt . . . to bake foundry cores . . . to preheat or cure plastics . . . to process foods, chemicals, textiles, wood, paper, etc.

THER-MONIC produces (note above) the country's widest range of *standard* heat treating equipment in various powers and frequencies.

They are versatile and efficient. You can bank on them to achieve uniform results—with unskilled labor . . . and not in minutes or hours—but in *precious* seconds!

We welcome the opportunity to recommend appropriate tooling and equipment guaranteed to produce the desired quality and production rates. Inquiries invited!

INDUCTION HEATING CORPORATION
181 WYTHE AVENUE, BROOKLYN 11, N. Y.
The most complete line of High Frequency Equipment

INDUCTION HEATING CORP. Dept. MP
181 Wythe Ave., Brooklyn 11, N. Y.

Gentlemen:

I would like more information about THER-MONIC Equipment for...

☐ Brazing ☐ Soldering ☐ Hardening ☐ Forging
☐ Annealing ☐ Melting ☐ Foundry Core Baking
☐ Dielectric Heating ☐ Rental Plans
☐ Have your representative call!

Name .....
Company .....
Title .....
Street ..... City .....
State .....

114. Dilatometer
Catalog Micro 8161 on equipment for thermal analysis of metals, ceramics. *Leitz*

115. Ductile Iron
List of publications available on advantages and properties of ductile iron, along with special applications and 100 authorized foundry sources now producing it. *International Nickel*

116. Electric Furnaces
Brochure on electric heat treating, melting, metallurgical tube, research and sintering furnaces. *Pereny Equipment*

117. Electric Furnaces
Booklet on four types of electric heating elements and their methods of mounting. *Holcroft*

118. Electrodes
Catalog on electrode line features assemblies for measurement, recording and control of solution pH and redox potentials. *Leeds & Northrup*

119. Enamel Finishes
Data on Plextone multicolored enamels includes colors, spray equipment, technical tips. *Maas & Waldstein*

120. Extrusion Presses
8-page bulletin on aluminum extrusion presses describes the processes and presses at work. *Watson-Stillman*

121. Fabricated Metal
Booklets on facilities for special metal fabrication and assembly. *Allied Metal Specialties*

122. Fasteners
4-page catalog on cold forged cap screws of high carbon, alloy and stainless steels. *Chandler Products Corp.*

123. Ferro-Alloys
32-page book tells how ferro-alloys are made and how they are used. *Electro Metallurgical Co.*

124. Finishing
52-page book "Advanced Speed Finishing" describes equipment for deburring and finishing. *Almco Div.*

125. Flame Analysis
New, pocket-size card with emission spectra for 36 of the most typical elements. *Beckman Instruments*

126. Flame Cutting
12-page booklet on use of automatic flame cutting in the making of machinery weldments. *Air Reduction Sales*

127. Flame Hardening
20-page booklet on precision flame hardening machine with electronic control. Details of operation and applications. *Cincinnati Milling Machine*

128. Flow Meters
Bulletin 201 on flow meter for gas used in heat treating. *Waukee Eng'g.*

129. Flow Meters
Catalog 2320 on indicating, recording integrating and controlling flow meters. *Minneapolis-Honeywell*

130. Flow Meters
24-page manual on application and installation of indicating flow meter. *Meriam Instrument*

131. Flow Regulation
Folder on self-operated flow regulator. *Fischer & Porter*

132. Fluoroscopy
12-page booklet on fluoroscopy for nondestructive internal inspection. Explains image amplifier. *Westinghouse Electric, Industrial X-Ray Dept.*

133. Forming Equipment
Bulletin on machinery and equipment for cold roll forming. *Am. Roller Die*

134. Foundry Coatings
Data on colloidal graphite for mold washes, pattern coatings, core coatings, chill coatings. *Acheson Colloids*

135. Free Cutting Steels
Manual gives history, chemistry, machinability, properties of free cutting Bessemer and basic openhearth steels. *Bliss & Laughlin*

136. Freezer
8-page folder on portable freezer, 110-volt a.c., operating to -180° F., for shrink fitting, hardening, stabilizing and testing. *Webber Mfg.*

137. Furnace Belts
44-page catalog describes metal belts for quenching, tempering, carburizing and other applications. *Ashworth Bros.*

138. Furnace Controls
Bulletin on instruments and controls for heat treating furnaces. *Hays Corp.*

139. Furnace Fixtures
Bulletin T-227 on Thermalloy trays and fixtures. *Electro-Alloys Div.*

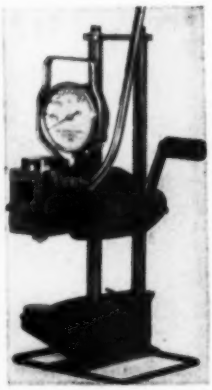
140. Furnace Fixtures
16-page catalog on baskets, trays, fixtures and carburizing boxes for heat treating. 66 designs. *Stanwood Corp.*

141. Furnace Insulation
Bulletin on ceramic fiber that can give impressive savings compared with high-quality insulating brick. *Refractories Div., Carborundum Co.*

142. Furnaces
Bulletin No. 200 on multi-burner heat treating furnace. *Am. Gas Furnace*

KING PORTABLE BRINELL

HARDNESS TESTER



Throat—4" deep. Gap—10" high. Weight—27 lbs.

Eliminates excessive material handling costs in routine and special Brinell hardness testing. The King Portable Brinell can be carried to the work, used in any position, and always puts an actual load of 3000 kg. on the 10mm. ball indenter.

This 27-lb. portable tester has a 4-in. deep throat and a gap 10 in. high. For larger pieces, the test head is easily removable for testing sections beyond the capacity of the standard base.

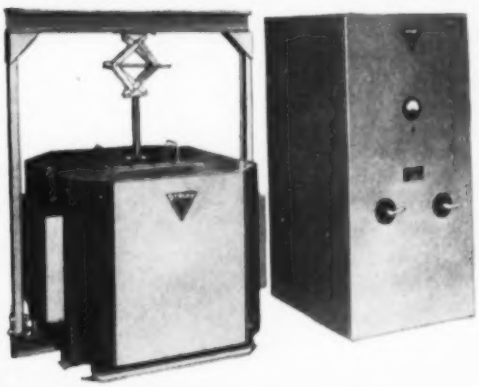
Simple to operate, the tester is impossible to overload, and even with inexperienced operators will provide consistent accurate results well within the requirements of the Bureau of Standards.

ANDREW KING

BOX 606 A

ARDMORE, PENNA.

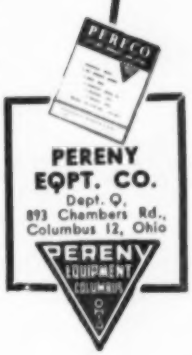
PERECO *Electric* FURNACES



PRESSURE SINTERING FURNACE

This high-temperature "pressure-sintering" Pereco Furnace (Model PF-1414-CR) is another of the many research applications for the versatile Pereco High-Temperature Furnaces. It has wide application for sintering bronze, iron, etc., under varying pressures at temperatures up to 2500° F.; and under normal atmosphere or "gas-tight" for controlled, reducing or neutral atmospheres. Compact overall size, with chamber size 14" x 14" x 18" deep. Furnished with any standard make or type temperature control to meet individual needs. Pivoted pressure-jack frame for easy loading. Ask for full specifications—or details on other models.

Standard and special furnaces for temperatures 450° to 5000° F.



143. Furnaces
Folder describes complete set-up for heat treatment of small tools, including draw furnace, quench tank and high temperature furnace. *Waltz Furnace*

144. Furnaces
40-page book describes gas and electric furnaces and applications. Four basic types of atmospheres. Glossary of heat treating terms. *Westinghouse*

145. Furnaces
New brochure on metallurgical furnaces in the melting, reheating and heat treating fields. *Rust Furnace Co.*

146. Furnaces
12-page brochure on car furnaces of special and conventional design. *Jet Combustion*

147. Furnaces, Heat Treating
Bulletin on fuel and electric furnaces for heat treating. *Dempsey*

148. Furnaces, Heat Treating
Catalog on furnaces for tool room and general purpose heat treat. *Cooley*

149. Furnaces, Heat Treating
32-page catalog on high-speed gas furnaces for heat treating carbon and alloy steels; also pot furnaces for salt and lead hardening. *Charles A. Hones*

150. Furnaces, Heat Treating
12-page bulletin on conveyor furnace, radiant tube gas heated, oil or electrically heated. *Electric Furnace Co.*

151. Galvanizing
Reprint "Modern Hot-Dip Galvanizing" deals with dross formation as a cause of zinc waste. *Hanson-Van Winkle-Munning*

152. Graphite Electrodes
Vest-pocket notebook containing 90 pages of information on electric furnace electrodes and other carbon products. *Great Lakes Carbon Corp.*

153. Grinding Magnesium
Data on how to grind and polish magnesium alloys includes grinding wheel recommendations, procedures, dust collection and safety precautions. *Norton*

154. Grinding Oils
16-page booklet on precision grinding oils. *D. A. Stuart*

155. Gold Plating
Article on analysis of gold and gold alloy plating solutions gives all currently available procedures. *Technic*

156. Gold Plating
Folder on salts for bright gold plating. Also lists equipment needed. *Sel-Rex*

157. Handling Devices
Pamphlets on clamps for lifting and handling. Their application to various industries. *Merrill Bros.*

158. Hardening Gears
How gears are carburized and martempered at Jack & Heintz. *Ajax Electric*

159. Hardness Tester
Booklet describes two models of Penetrascope hardness testers. *C. Tennant*

160. Hardness Tester
4-page bulletin on Brinell hardness tester weighing 26 lb. for portable and stationary use. *Andrew King*

161. Hardness Tester
13-page booklet on microhardness tester with optional Vickers or Knoop diamond. *Geo. Scherr*

162. Hardness Tester
20-page bulletin on use of portable hardness testers and accessories. *Ames Precision Machine*

163. Hardness Tester
20-page book on hardness testing by Rockwell method. *Clark Instrument*

164. Hardness Testers
Bulletin on superficial hardness testers for testing thin strip. *Wilson Mechanical Instrument*

165. Heat Resistant Alloy
Pyrasteel bulletin describes chromium-nickel-silicon alloy for service economy in resisting oxidation and corrosion to 2000° F. *Chicago Steel Foundry*

166. Heat Resistant Alloy
10-page article on how to get best service out of standard grades of heat resisting alloys by proper selection. *Rolled Alloys*

167. Heat Treat Baskets
Bulletin on wire mesh baskets for heat treating and plating. *Wiretex Mfg.*

168. Heat Treating
Bulletin 850 on shaker-hearth furnace for bright carburizing, carbonitriding, hardening. *Hevi Duty Electric*

169. Heat Treating
Bulletin 14-T on ovens for heat treatment of aluminum and other low-temperature processing. *Young Bros.*

170. Heat Treating
Catalog on HeaTreaT furnaces gives applications and performance features. *Heat Treating Supply Co.*

171. Heat Treating
Catalog N-35 on furnaces for hardening high speed steel. *Sentry Co.*

172. Heat Treating
Data on how to heat, quench, wash and temper automatically. *Metalwash Machinery*

SQUARES, FLATS, HEXAGONS, OCTAGONS, BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS.

OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE TO INDUSTRY

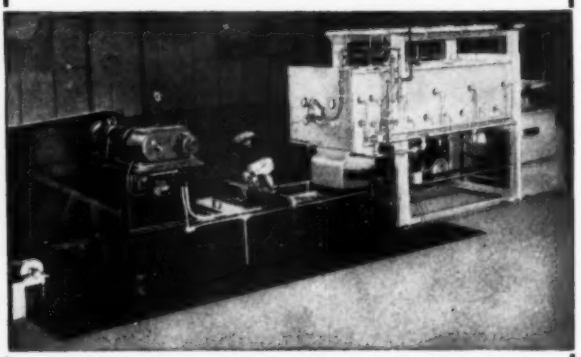
UP-TO-THE-MINUTE HY-TEN ALLOY STEELS

For over a century, Wheelock, Lovejoy & Company, Inc. has concentrated on the development of alloy and special steels with properties to meet individual needs. Today, WL has seven strategically located warehouses where you can get immediate delivery on any of the HY-TEN steels which have been developed by WL for unusual applications, plus many standard SAE and AISI grades. Every WL warehouse can supply these steels in rounds, squares, flats, hexagons, octagons, billets and forgings – every warehouse is staffed with expert metallurgists who are ready to assist you. Call on them.

Write today for your FREE COPIES of Wheelock, Lovejoy Data Sheets, indicating your title and company identification. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.

WHEELOCK, LOVEJOY & COMPANY, INC.
Warehouse Service
In Canada
HY-TEN and AISI
134 Sidney St., Cambridge 39, Mass.

CONTINUOUS HARDENING AND QUENCHING



By means of a smoothly operating reciprocating action the work constantly moves forward and feeds into the quench directly from the retort without air contact — A POSITIVE MEANS OF CLEAN HARDENING.

Ask AGF PIONEERS for Bulletins 815 and 820

AMERICAN GAS FURNACE CO
1002 LAFAYETTE STREET, ELIZABETH 4, N. J.

173. Heat Treating
Loose leaf data sheets on heat treating oils, salts, carburizing compounds. *Park Chemical*

174. Heat Treating Ammonia
24-page "Guide for Use of Anhydrous Ammonia" describes heat treating and other metallurgical uses. *Nitrogen Div.*

175. Heat Treating Fixtures
24-page catalog B-8 on muffles, retorts, baskets, other fixtures for heat treating in gas or salt baths. *Rolock*

176. Heat Treating Fixtures
24-page catalog on heat and corrosion-resistant equipment for heat treating and chemical processing. 30 classifications of equipment. *Pressed Steel*

177. Heat Treating Guide
Chart guide constructed on slide rule principle for simplified hardening and drawing of tool steels. *Carpenter Steel*

178. Heat Treatment
Bulletin 200 on car hearth, rotary hearth, pit, roller hearth, belt, chain, pusher "hi-head" furnaces. *R-S Furnace*

179. Heating
New booklet compares induction and dielectric high frequency heating. *New Rochelle Tool Corp.*

180. High-Alloy Castings
Bulletin 3150-G on castings for heat, corrosion, abrasion resistance. *Duraloy*

181. High-Strength Steel
66-page catalog on properties of Mayari*R steel. Applications which take advantage of its wear and corrosion resistance. *Bethlehem Steel*

182. High-Temperature Steels
87-page book on factors affecting high-temperature properties. 45 pages of data on tensile, creep and rupture properties of 21 high-temperature steels. *U.S. Steel*

183. High-Tensile Steel
Bulletin on nickel-copper steel of low-alloy, high-strength type. *Youngstown Sheet and Tube*

184. High-Vacuum Pumps
36-page Catalog 750 gives formulas, constants, conversions used in vacuum work, pump selection data. *Stokes*

185. High-Vacuum Pumps
Data sheet on physical dimensions, operating data and performance curves for high-vacuum oil diffusion pumps. *Consolidated Vacuum Corp.*

186. Identifying Stainless
Cardboard chart outlining systematic method for rapid identification of unknown or mixed stocks of stainless steels. *Carpenter Steel*

187. Induction Heating
Book contains selector chart and heating and melting speeds for induction equipment. *Ajax Electrothermic*

188. Induction Heating
Folder on bench-type electronic induction heating generators. *Induction Heating*

189. Induction Heating
4-page folder on aluminum strip rolled from continuously cast bar. *Ajax Eng.*

190. Induction Heating
36-page catalog on high frequency induction heating. *Lepel*

191. Input Controller
Bulletin on instrument for straight-line furnace temperature control. *Winslow Co.*

192. Insulation
40-page industrial products catalog on insulations, refractory products, and others. *Johns-Manville*

193. Laboratory Furnaces
Information and bulletins available along with current price lists on complete assortment of Lindberg laboratory furnaces. *Boder Scientific Co.*

194. Leaded Steels
Bulletin on analysis and advantages of cold finished leaded steel bars. *LaSalle*

195. Lubricant
8-page folder describes use of molybdenum disulfide lubricant in cold forming applications. *Alpha Corp.*

196. Lubricant
New literature on anti-seize molybdenum disulfide lubricant. *Bel-Ray*

197. Magnesium
42-page booklet on wrought forms of magnesium. Includes 31 tables. *White Metal Rolling & Stamping*

198. Magnesium Applications
60-page book gives 54 case studies on uses. *Dow Chemical*

199. Magnesium Welding
Reprint describes an investigation to evaluate inert-gas-shielded metal-arc welding of magnesium. *Air Reduction*

200. Magnetic Alloys
6 pages of data on Curie temperature of many alloys and how this phenomenon is of importance. *International Nickel*

201. Malleable Iron
Reprint 51-B on metallurgy, treatment, and heat treated properties of malleable iron. *Surface Combustion*

202. Master Alloys
Bulletin on custom-made alloys for remelt or reprocessing. *Cannon Muskegon*

203. Melting Furnace
Bulletin gives specifications, diagrams, performance and other technical data on Simplex melting furnaces. *Lindberg Engineering*

204. Metal Cutting
64-page catalog No. 29 gives prices and describes complete line of rotary files, burrs, metalworking saws and other products. *Martindale Electric*

205. Metal Working
48-page booklet on bolt and nut machining, power presses, wire mills and special machinery. *Waterbury Farrel Foundry & Machine*

206. Metallographic Equipment
12-page catalog E-29 describes bright-field equipment for visual observation and photography. *Bausch & Lomb*

207. Microhardness Tester
Bulletin describes the Kentron microhardness tester. *Torsion Balance Co.*

208. Moly-Sulphide Lubricant
40-page booklet on Moly-sulphide lubricant gives case histories for 154 different uses. *Climax Molybdenum*

209. Nitriding
Booklet tells about Floe process of nitriding. *Nitralloy Corp.*

210. Nondestructive Testing
8-page bulletin on equipment for nondestructive testing of bars, rods, tubing. *Magnetic Analysis*

211. Nonferrous Wire
Folder gives wire gage and footage chart and data on beryllium copper, phosphor bronze, nickel, silver, brass and aluminum wire. *Little Falls Alloys*

(Continued on page 32-A)



Up to 60% Silver Brazing Savings with

NEW LM EDGEWOUND WASHERS

Now NO TANGLE - NOTCH COIL WASHERS SNAP OFF COIL PREPLACE ON WORK

★ Produced from standard wire stocks. No lead time needed for dies or exact strip.

★ Suitable for use with induction, gas-air, furnace, or any of the commonly used heating methods.

★ Available in EASY FLO and SILFOS as well as Copper, Bronze and other alloys.

★ Diameters up to 4" I.D., wire thicknesses from .010 upward.

FREE 10 page booklet gives you all the facts on better brazing with preforms. Write Today!

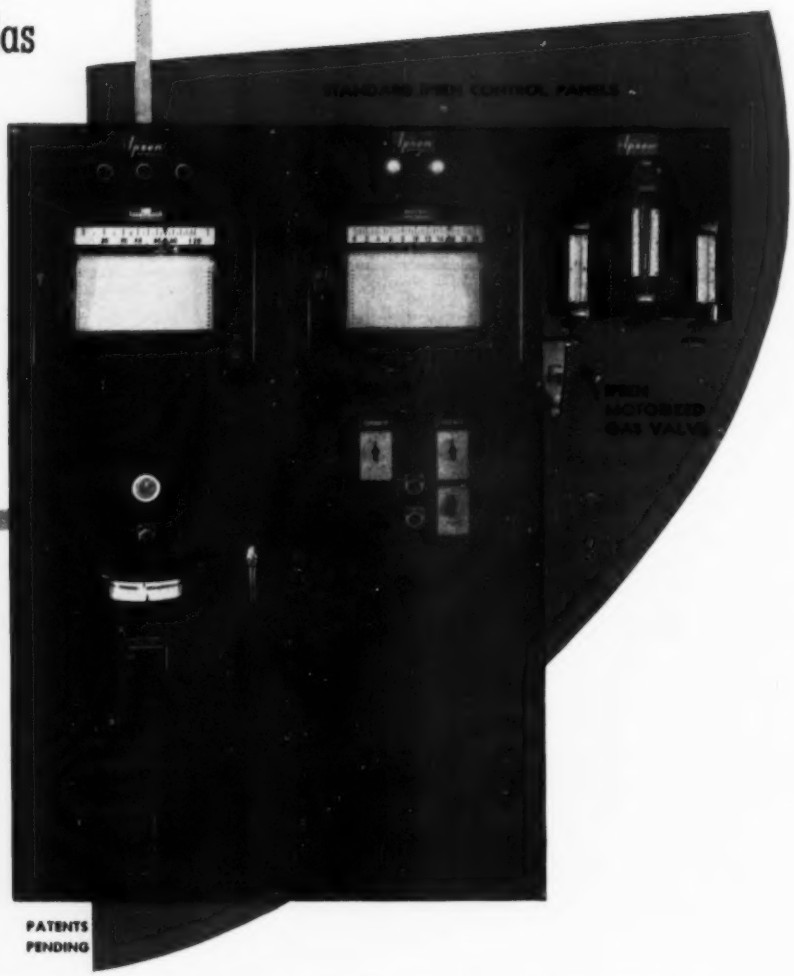
LUCAS-MILHAUPT ENGINEERING CO.

5056 S. LAKE DRIVE, CUDAHY, WISCONSIN

NOW...

You No Longer Need to Worry About the Amount Of Carburizing Gas to Add

Ipsen CARBOTRONIK



- Automatically controls furnace atmosphere carbon potential.
- Eliminates constant supervision and guesswork.
- Simply set the controls to desired carbon potential...and forget it.

AUTOMATIC **Ipsen** HEAT TREATING UNITS

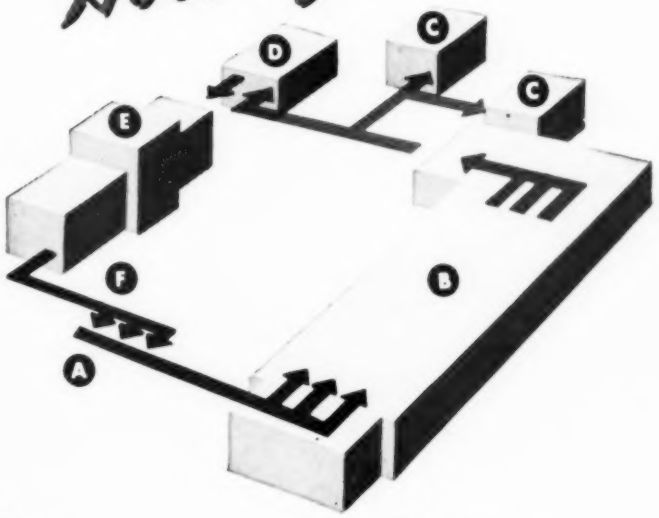
Universal Production Units in Standard Sizes 100 to 2000 LB./HR.

IPSEN INDUSTRIES, INC. 723 SOUTH MAIN STREET, ROCKFORD, ILLINOIS



Heat Treat Furnace Layout

by *Holcroft* ...8th of a Series



- **A** Load
- **B** 3-row Carburizing Furnace
- **C** Press Quench Machines
- **D** Quench Tank
- **E** Both parts feed through single row draw furnace
- **F** Unload

1 Furnace Layout Handles 2 Parts Saves time, man hours; cuts costs

Design experience paid off in this east coast plant. With two parts involved—both receiving the same heat treating cycle, but one requiring press quenching and the other selective hardening—the obvious answer seemed to be two separate layouts.

When given the problem, Holcroft engineers decided one layout would do. The work—drive gears and pinions—is now carburized in a 3-row pusher type furnace. After leaving the carburizing furnace the pinions are quenched by the tray load while the drive gears are individually press quenched and reloaded on trays. Both parts then continue on through the single-row draw furnace.

The results: substantial savings in both time and man-power.

Unusual? Not at all. Just another example of how experience and "know-how" pays off in time, money and job satisfaction.

Write today for complete information. Holcroft & Company, 6545 Epworth Blvd., Detroit 10, Michigan.

BUILT BY HOLCROFT & COMPANY DETROIT, MICH.

PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO, ILL. • CLEVELAND, OHIO • HOUSTON, TEXAS • PHILADELPHIA, PA.

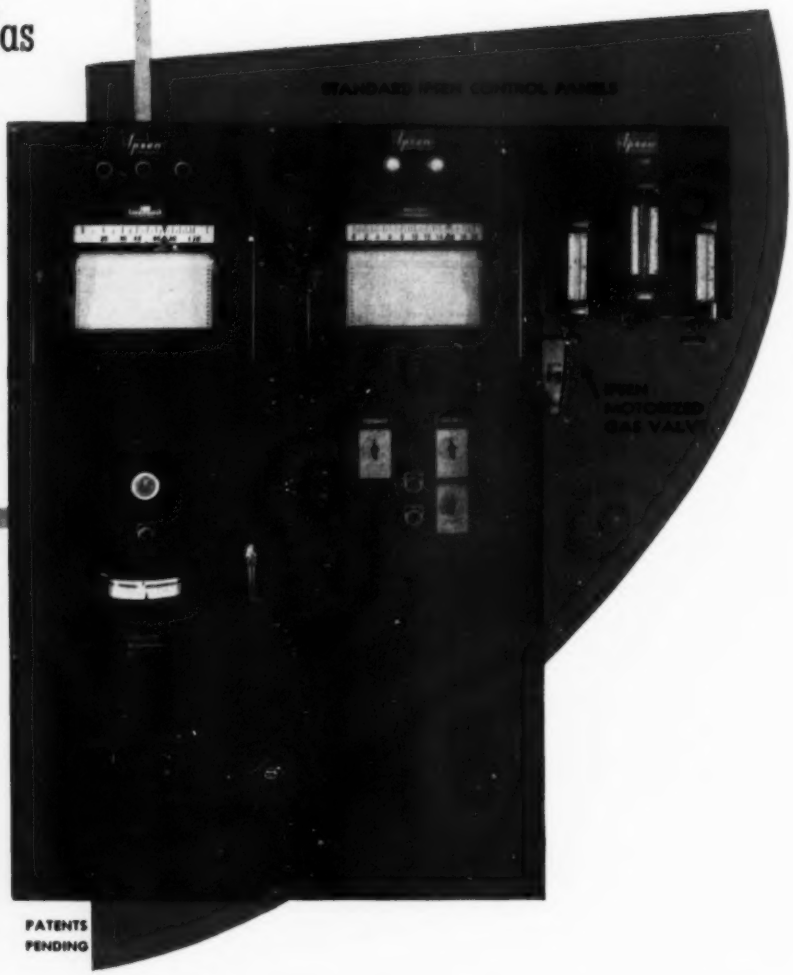
CANADA
Walker Metal Products, Ltd.
Windsor, Ontario

EUROPE
S. O. F. I. M.
Paris 8, France

NOW...

You No Longer Need to Worry About the Amount Of Carburizing Gas to Add

Ipsen CARBOTRONIK

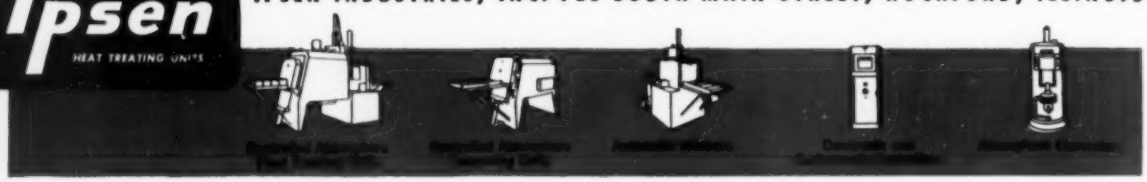


- Automatically controls furnace atmosphere carbon potential.
- Eliminates constant supervision and guesswork.
- Simply set the controls to desired carbon potential...and forget it.

Universal Production Units in Standard Sizes 100 to 2000 LB./HR.

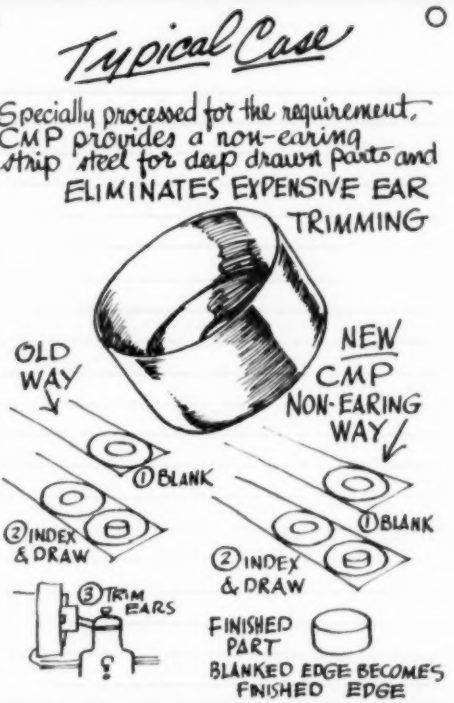
IPSEN INDUSTRIES, INC. 723 SOUTH MAIN STREET, ROCKFORD, ILLINOIS

AUTOMATIC Ipsen HEAT TREATING UNITS



CMP COLD ROLLED STRIP STEEL OFFERS *a practical way*

to reduce end-product costs WITHOUT CAPITAL INVESTMENT



CMP's precision rolling process permits production of cold rolled strip steel as thin as .001" to split-hair across-the-width gauge tolerances not obtainable by other rolling methods. This unique precision is reflected in less square footage loss through oversize variation, less wear on tools, fewer rejections and faster assembly where close fitting is encountered.

CMP processes also permit close control of physical characteristics to develop the combination of physicals best suited to the fabricating and service requirements of the application.

We'll be happy to work with you to develop specifications and processing methods to enable you to make the best possible product at the lowest possible cost.

the Cold Metal Products co.

GENERAL OFFICES: **YOUNGSTOWN 1, OHIO**

PLANTS: **YOUNGSTOWN, OHIO AND INDIANAPOLIS, INDIANA**

SALES OFFICES: New York • Cleveland • Detroit • Indianapolis; Chicago • St. Louis • Los Angeles • San Francisco

LOW CARBON, HIGH CARBON (Annealed or Tempered), STAINLESS AND ALLOY GRADES, ELECTRO ZINC COATED ARE AVAILABLE FROM:

THE COLD METAL PRODUCTS CO. OF CALIFORNIA
6600 McKinley Avenue, Los Angeles — Phone: PLeasant 3-1291

THE KENILWORTH STEEL CO., 750 Boulevard, Kenilworth, New Jersey
Phones: N. Y., COrtlandt 7-2427; N. J., UNionville 2-6900

PRECISION STEEL WAREHOUSE, INC.
4425 W. Kinzie, Chicago — Phone: COlumbus 1-2700



(Continued from page 31)

212. Nuclear Radiation Cell
Data on industrial instrumentation applications of the Ohmart cell, the radioactive sensitive element which converts nuclear radiation into electrical energy. *Minneapolis-Honeywell*

213. Pickling Baskets
Data on baskets for degreasing, pickling, anodizing and plating. *Jelliff*

214. Pickling Baskets
12-page bulletin on mechanical picklers, crates, baskets, chain and accessories. *Youngstown Welding & Eng'g*

215. Plating
Bulletin of products for zinc, cadmium, copper and white brass plating. *Swift*

216. Plating Rectifiers
4-page folder on selenium rectifiers for plating and anodizing. *United Chromium*

217. Powdered Metal Parts
Bulletin points out powdered metal parts which can be molded or must be machined. *Chicago Powdered Metal Products.*

218. Powdered Metals
Bulletin 800-A on pre-alloyed iron powders with varied chromium-nickel contents. *Metal Hydrides*

219. Precision Casting
8-page bulletin on investment castings of various ferrous and nonferrous alloys. *Engineered Precision Casting*

220. Precision Casting
44-page Catalog 53 covers every stage of the investment casting process. *Alexander Saunders*

221. Precision Casting
20-page booklet on ethyl silicate as a refractory mold binder for precision investment casting. *Carbide and Carbon Chemicals Co.*

222. Precision Castings
20-page book on alloys used, specification ranges, advantages and castings made by precision casting. *Haynes Stellite*

223. Presses
Catalog of power press brakes for sheet metal and plate. Applications possible with various dies. Design and manufacture. *Airtherm Mfg. Co.*

224. Presses
8-page booklet on hand and power operated benders, brakes, notchers, punch presses. *O'Neil-Irwin Mfg.*

225. Presses
16-page booklet on recommendations for modernization and conversion of straight-side and gap-frame double crank presses. *E. W. Bliss*

226. Protective Coating
New folder on brush Alodine protective coating for aluminum. *American Chemical Paint*

227. Protective Coatings
Comparison chart of twelve protective coatings gives resistance of each to abrasion and different corrosive mediums. *Industrial Metal Protectives*

228. Pyrometer Calibration
New issue of "Pyrometer Thermocouple Calibration Data" includes tables of data recently released by National Bureau of Standards. *Bristol Co.*

229. Quenching
8-page reprint on hot oil quenching of tractor shovel parts. *Surface Combustion*

230. Quenching
"Handbook on Quenching" gives complete information. *E. F. Houghton*

231. Quenching
New catalog on two small self-contained quenching units. *Bell & Gossett*

232. Quenching Oil
10-page book on new oils for the quenching process gives results on hot wire quench test and in plant operation. *Sinclair Refining Co.*

233. Radiamatic Pyrometers
Catalog 9301 on four types of radiation detectors for measuring temperatures from 125 to 7000° F. *Minneapolis-Honeywell*

234. Rare Earths
8-page Progress Report Number 1, "Rare Earths in Iron and Steel Melting". *Molybdenum Corp.*

235. Recirculating Furnaces
16-page Bulletin 81 describes heat treating furnaces for ferrous and nonferrous parts and other heat treat equipment. *Despatch Oven*

236. Recorder Controllers
48-page ND 46(1) gives specifications, installation pictures of recorders and controllers for temperature, strain, other variables. *Leeds & Northrup*

237. Refractories
16-page book on mullite-base refractories—ramming mixes, mortars, patches, castables. *Mullite Refractories*

238. Refractories
Booklet on recommendations for high-temperature insulation in openhearth furnaces. *Illinois Clay Products Co.*

239. Refractory Cement
Bulletin discusses refractories and heat-resistant concrete. *Lumnite Div.*

240. Refractory Mixes
16-page bulletin 315 on properties and applications of sillimanite super-refractory ramming mixes and furnace patches. *Chas. Taylor Sons*

241. Roll Formed Shapes
24-page Bulletin 1053 on designing, forming and producing shapes from ferrous and nonferrous metals. *Roll Formed Products Co.*

242. Rubber Linings
8-page bulletin on use of rubber lined pipes and tanks includes tables on their chemical, abrasive and temperature resistant qualities. *Metalweld, Inc.*

243. Rupture Discs
New bulletin on uses of precious metal rupture discs for instant release of excess pressure. *Baker & Co.*

244. Rust Preventive
Pamphlet on Oilcoat T for prevention of rust in lubricating systems. *Gulf Oil*

245. Rust Preventives
12-page bulletin on water-soluble rust-preventive. *Production Specialties*

246. Rust-Proofing
Literature on rust-proofing ferrous metal parts. *American Chemical Paint*

247. Salt Baths
Hardening textile machinery parts in neutral salt baths in "Tips and Trends". *Ajax Electric*

248. Salt Baths
32-page bulletin on salts for tempering, annealing, neutral hardening, martempering and carburizing. *E. F. Houghton*

249. Salt Bath Furnaces
Data on salt bath furnaces for batch and conveyorized work. *Upton*

250. Shearing
16-page catalog on pivoted-blade shears for cutting metal up to 1.25 in. thick. *Cleveland Crane & Engineering*

251. Sheet Metal Testing
8-page folder on equipment for testing the drawing, stamping and folding qualities of sheet and strip. *Deakin*

252. Shot Peening
16-page booklet on selection and use of shot and grit for peening. *Cleveland Metal Abrasive*

253. Silver Brazing
10-page technical bulletin on brazing

FIRST CLASS
PERMIT No. 1595
(Sec. 34.9 P.L. & R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

4c POSTAGE WILL BE PAID BY—

METAL PROGRESS
7301 Euclid Avenue
CLEVELAND 3, OHIO



preforms. Specifications for 13 types of joints. *Lucas-Milhaupt*

254. Soldering Aluminum

6-page folder on use of a noncorrosive flux for soldering aluminum. Data on joint strength and ductility. *Insulation and Wires, Inc.*

255. Specifications Index

28-page cross index lists copper alloy specifications of nine different Government agencies. *American Brass*

256. Spectro-Analysis

Catalog V3 on excitation units for precision spectrochemical analysis. *Jarrell-Ash*

257. Spectrograph

20-page catalog describes large Littrow spectrograph, medium quartz spectrograph and densitometer for spectrum analysis. *Bausch & Lomb*

258. Spectrometer

Data sheet on Raman spectrographic equipment for large-volume analytical work. *Minneapolis-Honeywell*

259. Spring Steels

Spring steel catalog offers 785 sizes of hardened and tempered spring steels, and 133 cold rolled and bright annealed sizes in stock. *Sandvik Steel*

260. Stainless Fastenings

20-page catalog of stainless steel cap screws, nuts, washers, machine screws, sheet metal screws, set screws, pipe fittings and specialties. *Star Stainless Screw*

261. Stainless Steel

Bulletin shows plates, forgings, sheets, tank heads, flanges. *G. O. Carlson*

262. Stainless Steel

44-page book gives detailed information on use of stainless steel in the chemical industries. *Crucible Steel*

263. Stainless Steel

Reference chart lists chemical analyses, physical properties and recommended applications for 28 different grades of cast stainless steel. *Cooper Alloy Foundry*

264. Stainless Steels

20-page book on uses of stainless steels. *Electro Metallurgical*

265. Stainless Tubing

28-page book on corrosion, uses and fabrication of stainless steel tubing. *Steel and Tubes Div., Republic*

266. Steels for Agriculture

20-page book on steels used in agriculture. *Crucible Steel Co.*

267. Stretchforming

Bulletin on how a structural member was formed on a contour former. *Cyril Bath*

268. Subzero Freezer

Data on chest for use down to −95° F. for production use and testing. *Revco*

269. Super High Speed Steel

Folder on molybdenum, 8% cobalt high speed steel. *Firth Sterling.*

270. Tellurium Copper

6-page pamphlet on properties of 0.5% tellurium copper alloy. *Chase Brass*

271. Tempilstiks

"Basic Guide to Ferrous Metallurgy", a plastic laminated wall chart in color. *Claud S. Gordon*

272. Testing Controllers

Bulletin 48 on program controllers for production and quality control testing, research and development. *Tinius Olsen*

273. Testing Machines

32-page catalog on hydraulic testing machines. 10 models described; also accessories. *Riehle*

274. Textured Stainless

Folder on stainless to conserve alloys and reduce weight. *Rigidized Metals*

275. Thermocouple Elements

Folder on precious metal, chromel and alumel thermoelements, porcelain and metal protection tubes. *Chas. Engelhard*

276. Thermocouples

New 8-page catalog of enclosed tip thermocouples. *L. H. Marshall Co.*

277. Thermocouples

Catalog of pyrometer supplies gives data on thermocouples, protection tubes, other accessories. *Arklay S. Richards*

278. Timer

Bulletin GEC-1223 on new single or double-circuit process timer. *G.E.*

279. Titanium

30-page data book on properties of commercially pure and alloy titanium, melting, forging and rolling. 16 charts and micros; 4 hardness conversion curves for titanium. *Republic Steel*

280. Tube and Pipe

8-page booklet on welded ornamental, mechanical or pressure tubing of stainless, carbon or alloy steel. *Wallingford Steel*

281. Tubing

52-page "Handbook of Seamless Steel Tubing". 26 pages of data. *Timken*

282. Tubing

48-page catalog of welded stainless and high alloy tubing from ⅛ to 40 in. *Trent Tube Co.*

283. Tool Steel

20-page booklet on selection of proper tool steel support material for use with carbide tools. *Allegheny Ludlum*

284. Tool Steel Selector

Twist the dial of the 9-in. circular selector and read off the tool steel for your application. *Crucible Steel*

285. Ultrasonic Cleaning

Folder on Sonogen ultrasonic generator for metal cleaning. *Branson*

286. Ultra Strength Steel

Results of three year research and test program evaluating properties of Type 4340 steel for aircraft structures. *International Nickel*

287. Vacuum Pumps

24-page Bulletin V51 on high-vacuum pumps and accessories. *Kinney Mfg.*

288. Welding

Booklet on recent applications of flash welding to ferrous alloys and stainless. *Thomson Electric Welder*

289. Welding

Bulletin 2100 on air-operated bench welder for spot welding. *Universal Welder*

290. Welding

16-page booklet on how to weld high alloy castings of the straight chromium, chromium-nickel and heat-resistant types. *Alloy Casting Institute*

291. Welding Equipment

Catalog on Cadweld process and arc-welding accessories. *Erico Products*

292. Welding Stainless

Folder on the welding of stainless tubing and pipe. *Babcock & Wilcox*

293. Wire Baskets

84-page book on fabricated baskets for dipping and heat treating. *Cambridge Wire Cloth*

294. Zirconia

Folder on new, patented process in which each zirconia crystal is stabilized. Characteristics of stabilized zirconia. *Zirconium Corp. of America*

295. Zirconium

26-page booklet gives physical, mechanical and chemical properties, present and potential uses, supply and prices of zirconium. *Zirconium Metals*

July, 1954

1	25	49	73	97	121	145	169	193	217	241	265	289
2	26	50	74	98	122	146	170	194	218	242	266	290
3	27	51	75	99	123	147	171	195	219	243	267	291
4	28	52	76	100	124	148	172	196	220	244	268	292
5	29	53	77	101	125	149	173	197	221	245	269	293
6	30	54	78	102	126	150	174	198	222	246	270	294
7	31	55	79	103	127	151	175	199	223	247	271	295
8	32	56	80	104	128	152	176	200	224	248	272	
9	33	57	81	105	129	153	177	201	225	249	273	
10	34	58	82	106	130	154	178	202	226	250	274	
11	35	59	83	107	131	155	179	203	227	251	275	
12	36	60	84	108	132	156	180	204	228	252	276	
13	37	61	85	109	133	157	181	205	229	253	277	
14	38	62	86	110	134	158	182	206	230	254	278	
15	39	63	87	111	135	159	183	207	231	255	279	
16	40	64	88	112	136	160	184	208	232	256	280	
17	41	65	89	113	137	161	185	209	233	257	281	
18	42	66	90	114	138	162	186	210	234	258	282	
19	43	67	91	115	139	163	187	211	235	259	283	
20	44	68	92	116	140	164	188	212	236	260	284	
21	45	69	93	117	141	165	189	213	237	261	285	
22	46	70	94	118	142	166	190	214	238	262	286	
23	47	71	95	119	143	167	191	215	239	263	287	
24	48	72	96	120	144	168	192	216	240	264	288	

METAL PROGRESS,

7301 Euclid Avenue, Cleveland 3, Ohio

Please have literature circled at the left sent to me.

Name _____

Title _____

Company _____

Address _____

City and State _____

Postcard must be mailed prior to Oct. 1, 1954
Students should write direct to manufacturers


Latrobe's new
Free Machining
OLYMPIC
FM
"Desegatized"®
high production
AIR-HARDENING
Die Steel*
Manufactured under
Patent No. 2204283
Tests show as much as
50% reduction in
machining time
No change in physical properties or in the heat
treatment normally associated with D-2 type die steel.
Contact your Latrobe representative or write direct to Latrobe, Pa. for complete information.
*D-2 Type
Latrobe
STEEL COMPANY
LATROBE, PA.
Branch Offices and Warehouses — BOSTON BUFFALO CHICAGO CLEVELAND DAYTON
DETROIT HARTFORD LOS ANGELES MILWAUKEE NEWARK PHILADELPHIA
PITTSBURGH ST. LOUIS ST. PAUL TORRANCE
Sales Agents — ATLANTA CHARLOTTE DALLAS DENVER HOUSTON SALT LAKE CITY WICHITA
European Offices — GENEVA BRUSSELS PARIS MILAN ROTTERDAM DUSSELDORF

preforms. Specifications for 13 types of joints. *Lucas-Milhaupt*

254. Soldering Aluminum
6-page folder on use of a noncorrosive flux for soldering aluminum. Data on joint strength and ductility. *Insulation and Wires, Inc.*

255. Specifications Index
28-page cross index lists copper alloy specifications of nine different Government agencies. *American Brass*

256. Spectro-Analysis
Catalog V3 on excitation units for precision spectrochemical analysis. *Jarrell-Ash*

257. Spectrograph
20-page catalog describes large Littrow spectrograph, medium quartz spectrograph and densitometer for spectrum analysis. *Bausch & Lomb*

258. Spectrometer
Data sheet on Raman spectrographic equipment for large-volume analytical work. *Minneapolis-Honeywell*

259. Spring Steels
Spring steel catalog offers 785 sizes of hardened and tempered spring steels, and 133 cold rolled and bright annealed sizes in stock. *Sandvik Steel*

260. Stainless Fastenings
20-page catalog of stainless steel cap screws, nuts, washers, machine screws, sheet metal screws, set screws, pipe fittings and specialties. *Star Stainless Screw*

261. Stainless Steel
Bulletin shows plates, forgings, sheets, tank heads, flanges. *G. O. Carlson*

262. Stainless Steel
44-page book gives detailed information on use of stainless steel in the chemical industries. *Crucible Steel*

263. Stainless Steel
Reference chart lists chemical analyses, physical properties and recommended applications for 28 different grades of cast stainless steel. *Cooper Alloy Foundry*

264. Stainless Steels
20-page book on uses of stainless steels. *Electro Metallurgical*

265. Stainless Tubing
28-page book on corrosion, uses and fabrication of stainless steel tubing. *Steel and Tubes Div., Republic*

266. Steels for Agriculture
20-page book on steels used in agriculture. *Crucible Steel Co.*

267. Stretchforming
Bulletin on how a structural member was formed on a contour former. *Cyril Bath*

268. Subzero Freezer
Data on chest for use down to —95° F. for production use and testing. *Revco*

269. Super High Speed Steel
Folder on molybdenum, 8% cobalt high speed steel. *Firth Sterling.*

270. Tellurium Copper
6-page pamphlet on properties of 0.5% tellurium copper alloy. *Chase Brass*

271. Tempilstiks
"Basic Guide to Ferrous Metallurgy", a plastic laminated wall chart in color. *Claud S. Gordon*

272. Testing Controllers
Bulletin 48 on program controllers for production and quality control testing, research and development. *Tinius Olsen*

273. Testing Machines
32-page catalog on hydraulic testing machines. 10 models described; also accessories. *Riehle*

274. Textured Stainless
Folder on stainless to conserve alloys and reduce weight. *Rigidized Metals*

275. Thermocouple Elements
Folder on precious metal, chromel and alumel thermoelements, porcelain and metal protection tubes. *Chas. Engelhard*

276. Thermocouples
New 8-page catalog of enclosed tip thermocouples. *L. H. Marshall Co.*

277. Thermocouples
Catalog of pyrometer supplies gives data on thermocouples, protection tubes, other accessories. *Arklay S. Richards*

278. Timer
Bulletin GEC-1223 on new single or double-circuit process timer. *G.E.*

279. Titanium
30-page data book on properties of commercially pure and alloy titanium, melting, forging and rolling. 16 charts and micros; 4 hardness conversion curves for titanium. *Republic Steel*

280. Tube and Pipe
8-page booklet on welded ornamental, mechanical or pressure tubing of stainless, carbon or alloy steel. *Wallingford Steel*

281. Tubing
52-page "Handbook of Seamless Steel Tubing". 26 pages of data. *Timken*

282. Tubing
48-page catalog of welded stainless and high alloy tubing from ⅛ to 40 in. *Trent Tube Co.*

283. Tool Steel
20-page booklet on selection of proper tool steel support material for use with carbide tools. *Allegheny Ludlum*

284. Tool Steel Selector
Twist the dial of the 9-in. circular selector and read off the tool steel for your application. *Crucible Steel*

285. Ultrasonic Cleaning
Folder on Sonogen ultrasonic generator for metal cleaning. *Branson*

286. Ultra Strength Steel
Results of three year research and test program evaluating properties of Type 4340 steel for aircraft structures. *International Nickel*

287. Vacuum Pumps
24-page Bulletin V51 on high-vacuum pumps and accessories. *Kinney Mfg.*

288. Welding
Booklet on recent applications of flash welding to ferrous alloys and stainless. *Thomson Electric Welder*

289. Welding
Bulletin 2100 on air-operated bench welder for spot welding. *Universal Welder*

290. Welding
16-page booklet on how to weld high alloy castings of the straight chromium, chromium-nickel and heat-resistant types. *Alloy Casting Institute*

291. Welding Equipment
Catalog on Cadweld process and arc-welding accessories. *Erico Products*

292. Welding Stainless
Folder on the welding of stainless tubing and pipe. *Babcock & Wilcox*

293. Wire Baskets
84-page book on fabricated baskets for dipping and heat treating. *Cambridge Wire Cloth*

294. Zirconia
Folder on new, patented process in which each zirconia crystal is stabilized. Characteristics of stabilized zirconia. *Zirconium Corp. of America*

295. Zirconium
26-page booklet gives physical, mechanical and chemical properties, present and potential uses, supply and prices of zirconium. *Zirconium Metals*

July, 1954

1	25	49	73	97	121	145	169	193	217	241	265	289
2	26	50	74	98	122	146	170	194	218	242	266	290
3	27	51	75	99	123	147	171	195	219	243	267	291
4	28	52	76	100	124	148	172	196	220	244	268	292
5	29	53	77	101	125	149	173	197	221	245	269	293
6	30	54	78	102	126	150	174	198	222	246	270	294
7	31	55	79	103	127	151	175	199	223	247	271	295
8	32	56	80	104	128	152	176	200	224	248	272	
9	33	57	81	105	129	153	177	201	225	249	273	
10	34	58	82	106	130	154	178	202	226	250	274	
11	35	59	83	107	131	155	179	203	227	251	275	
12	36	60	84	108	132	156	180	204	228	252	276	
13	37	61	85	109	133	157	181	205	229	253	277	
14	38	62	86	110	134	158	182	206	230	254	278	
15	39	63	87	111	135	159	183	207	231	255	279	
16	40	64	88	112	136	160	184	208	232	256	280	
17	41	65	89	113	137	161	185	209	233	257	281	
18	42	66	90	114	138	162	186	210	234	258	282	
19	43	67	91	115	139	163	187	211	235	259	283	
20	44	68	92	116	140	164	188	212	236	260	284	
21	45	69	93	117	141	165	189	213	237	261	285	
22	46	70	94	118	142	166	190	214	238	262	286	
23	47	71	95	119	143	167	191	215	239	263	287	
24	48	72	96	120	144	168	192	216	240	264	288	

METAL PROGRESS,

7301 Euclid Avenue, Cleveland 3, Ohio

Please have literature circled at the left sent to me.

Name _____

Title _____

Company _____

Address _____

City and State _____

Postcard must be mailed prior to Oct. 1, 1954
Students should write direct to manufacturers



Tests show as much as **50%** reduction in machining time

No change in physical properties or in the heat treatment normally associated with D-2 type die steel.

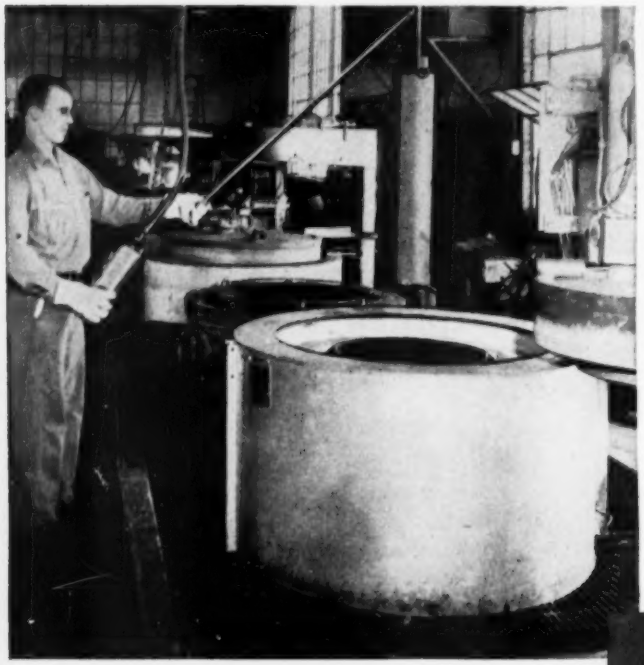
Contact your Latrobe representative or write direct to Latrobe, Pa. for complete information.

*D-2 Type

Latrobe
STEEL COMPANY
LATROBE, PA.

Branch Offices and Warehouses — BOSTON BUFFALO CHICAGO CLEVELAND DAYTON DETROIT HARTFORD LOS ANGELES MILWAUKEE NEWARK PHILADELPHIA PITTSBURGH ST. LOUIS ST. PAUL TOLEDO.
Sales Agents — ATLANTA CHARLOTTE DALLAS DENVER HOUSTON SALT LAKE CITY WICHITA
European Offices — GENEVA BRUSSELS PARIS MILAN ROTTERDAM DUSSELDORF

4 REPORTS ON MICROCARB® CONTROL... FROM PRODUCTION HEAT TREATS

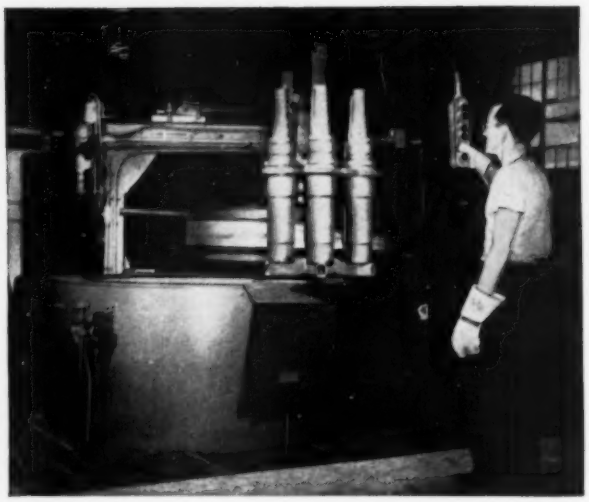


1 TOLERANCES HELD

● This row of L&N furnaces is in the Heat Treating Department of Jones and Lamson, Springfield, Vt., manufacturers of turret and automatic lathes, thread grinders, comparators, dies and chasers. In the foreground is a Homocarb furnace with Microcarb Control—panels are against the wall at the right.

The part being removed is a work slide bar for a J&L Model D Vertical Slide Form Grinder. The bar is made from 5% chrome, 1% carbon air hardening steel. Specifications are 64 plus, in Rockwell C uniform surface hardness. These bars are ground to a ± .0002 inch tolerance on outside dimensions and zero on straightness and eccentricity and must remain stable. Control of surface carbon chemistry and distortion during heat treatment are extremely important.

● At right is an adjusting cone for the spring collet on a J&L Bar Type Turret Lathe. These cones are 8″ in diameter by 5″ deep with ⅜″ walls, and are made from 5% chrome, 0.10% carbon air hardening carburizing steel. While machining and physical characteristics of this steel are excellent, it requires precise control of furnace atmosphere during carburizing to meet J&L's requirements for uniform surface hardness of 60 to 63 Rockwell C. J&L carburize these parts at 1750 F with Microcarb atmosphere control—air cool then stress relieve them in an L&N Homo Tempering furnace at 300 F. They report not only that they have no difficulty meeting specifications on individual loads, but can reproduce the same cycle time after time.



2 DISTORTION NEGLIGIBLE

● Taft-Peirce in Woonsocket, R. I. installed their Homocarb® furnace with Microcarb Control to improve physical characteristics . . . particularly by maintaining surface carbon content during hardening of these aircraft "prop" shafts made of AMS 6415 steel. Each shaft measures 6 inches in diameter by 30 inches long and weighs 125 pounds.

Six shafts are run at once . . . loads are brought to 1550 F and held for 4 hours with a carbon setting of 0.45% . . . then oil quenched. The firm reports that specifications—for strength, elongation, reduction in area, etc.—are held without difficulty on every load; work comes out clean and distortion is negligible.

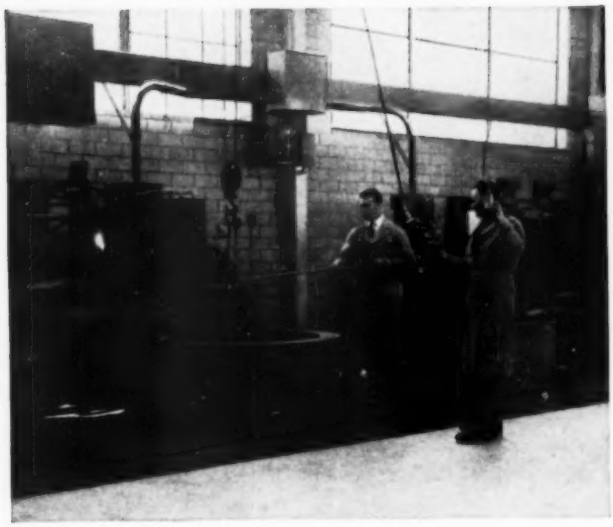




3 FINISHING REDUCED

● Just in front of the control panels is the 15″ x 18″ Homocarb furnace with Microcarb Control in which the W. H. Nichols Company, Waltham, Mass., heat treat aircraft gears like the one above. The gears, measuring 3½ inches in diameter, are made of AMS 6260 and 6274 nickel-chromium-molybdenum steel. Prescribed specifications call for a minimum 81 Rockwell "A" hardness, with a .025 to .040 case free of carbide network. The operator simply sets temperature control to 1650 F and carbon control to 0.90.

Nichols also uses this furnace to harden AISI 4140 steel pump shafts. The precise L&N control eliminates undesirable decarburizing or carburizing and substantially reduces successive finishing operations that were formerly necessary.

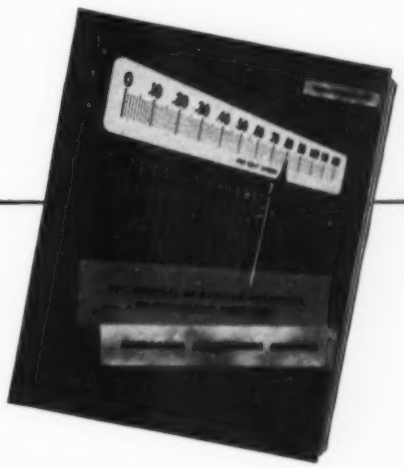


4 OPERATION AUTOMATIC

● These Homocarb furnaces with Microcarb Control are used for production-line carburizing and heat treating of Universal Joint spiders made by Warner Machine Products Inc. Twenty-four of the large spiders are loaded at a time. Material is SAE-8720 steel. The load is held at 1700 F to obtain a 0.090 inch case depth with the atmosphere controlled at 0.90% to 0.95% carbon. Parts are cooled in the furnace to about 1525 F then direct oil quenched. Warner obtains a hardness of about 63 Rockwell C.

Although none of the operating personnel in this Warner Machine Plant had ever had any experience in carburizing and heat treating prior to this installation, control is so automatic that some 800,000 pounds of work were run through Warner's four furnaces in the first few months without a single loss due to heat treatment.

For More Information about Microcarb Atmosphere Control

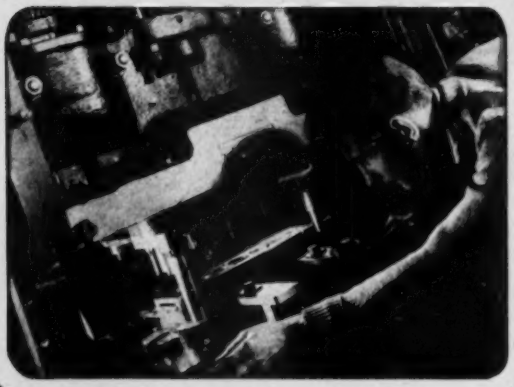


● Here's a new catalog that's yours for the asking. It explains the basic Microcarb principle which, for the first time, makes possible a direct continuous measurement of carbon potential in furnace atmosphere during the entire heating cycle. Just write us at 4927 Stenton Ave., Phila. 44, Pa., and ask for your copy of Catalog TD4-620(2).

LEEDS NORTHRUP
instruments automatic controls • furnaces

telling the story of 'dag' dispersions

Lubrication Troubles Above 500° F? Try This!



Use a 'dag' dispersion. At high temperatures it has conventional lubricating agents beat a mile. Why? Because at ordinary metalworking temperatures it doesn't burn off, flake, or gum up. It successfully battles oxidation at every temperature up to 750°F.

'dag' dispersions of graphite form microscopically thin, *dry lubricating films* which fight friction beyond the burning-points of most oils. These dry films are unaffected by heat up to 750°F. . . . under some conditions up to 3000°F.

For more details on metalworking applications write for Bulletin No. 426-G7.

* * *

Dispersions of molybdenum disulfide are available in various carriers.

We are also equipped to do custom dispersing of solids in a wide variety of vehicles.

dag DISPERSIONS

Acheson Colloids Company, Port Huron, Mich.
...also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

try resin-bonded dry graphite films for permanent lubrication

you get a hard case a tough core

and No Zone of Fracture between them with

Houghton PERLITON 396

Get tougher, less brittle, more ductile carburized parts with Perliton 396 carburizing salt. It's easy and economical to use, too—soluble in water, easy to clean—needs no starting salt—forms its own insulating crust—bath is stable.

Get full information on Perliton 396, or on any other heat-treating salt, from your Houghton Man—or write E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

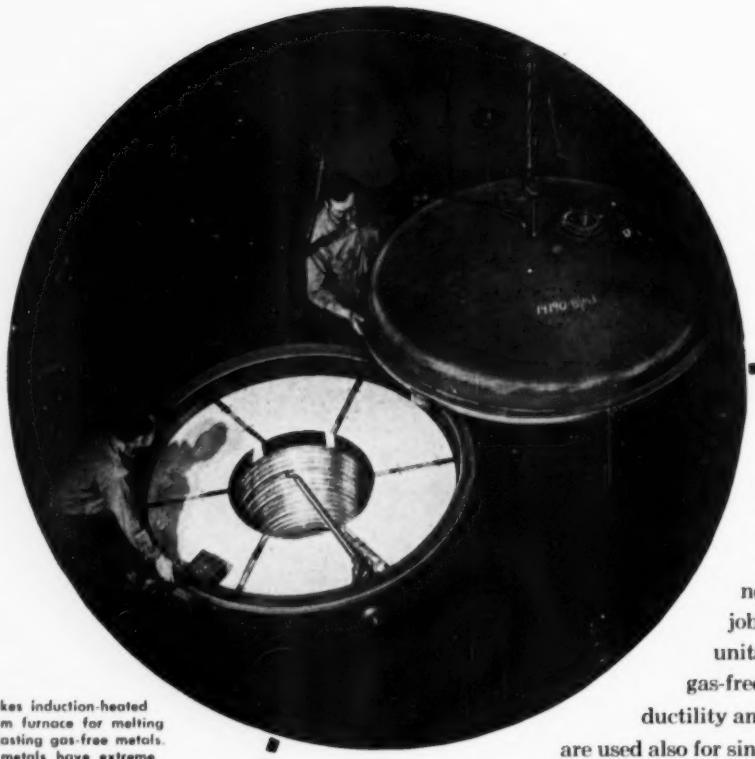
PERLITON 396
. . . a product of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO



Ready to give you on-the-job service . . .

Need High-Purity Metals in 1000-pound Quantities?



A Stokes induction-heated vacuum furnace for melting and casting gas-free metals. Such metals have extreme purity, high ductility, great impact and rupture strength, improved creep resistance and exceptional performance qualities.

Stokes is *building* practical vacuum furnaces to supply that need . . . *designing* for 2000-pound jobs . . . *planning* for 5000-pound units . . . for melting and casting gas-free metals of extreme purity, high ductility and great strength. These furnaces are used also for sintering, annealing and degassing.

You can have Stokes vacuum furnaces for top or bottom pouring, for single or multiple ingots, for centrifugal castings. We build tilting type induction-heated melting furnaces of 10 to 1000 pounds capacity; movable retort resistance-heated furnaces for degassing and annealing in 10, 20 and 30-inch retort sizes; resistance-heated furnaces with removable heat source or with bell-type retort; two-zone furnaces with movable boat, and others.

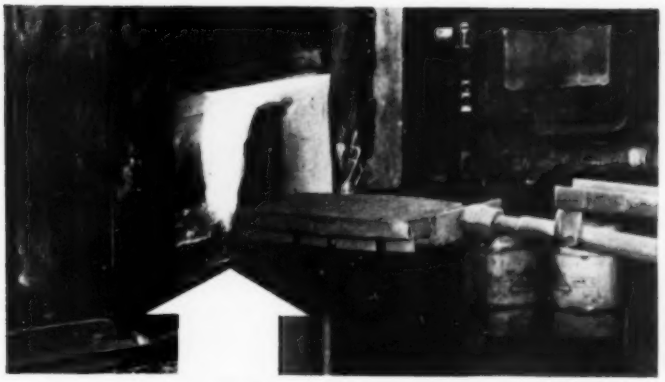
We supply complete, integrated "package" units engineered completely and specifically to meet the particular need for vacuum pumping capacity, heating input and any mechanical actuation required to control operations in the vacuum chamber.

Most important . . . we bring to every vacuum furnace problem the value of 40 years' *practical* experience in building vacuum equipment and guiding its installation and adjustment to efficient operation in the field.

F. J. Stokes Machine Company, Philadelphia 20, Pa.

STOKES

STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment

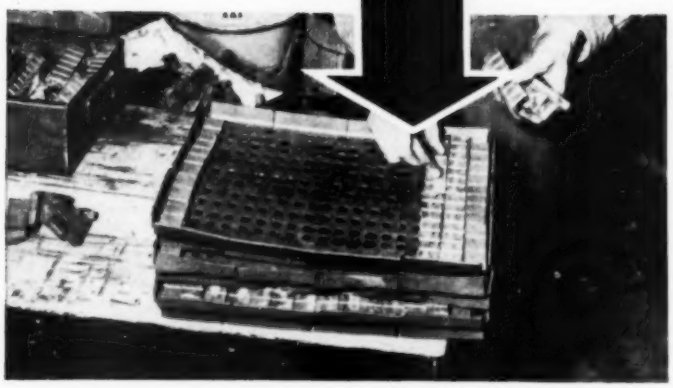


At General Magnetic Corporation, 10001 Erwin Street, Detroit, Michigan, magnets are brought up to heat, 2400°F. in one hour, soaked 20 minutes, then cooled in 10 minutes to 300-400°F. They ride in Inconel trays with Inconel covers to protect them against direct heat.

UP to 2400° F.

DOWN to "Handling cool" 6 times daily

Yet Inconel trays and covers serve a full six months treating Alnico magnets



After discharge trays are allowed to cool to handling temperature, then reloaded 6 to 7 times daily. Expansion slots help reduce stresses created by cycling between temperature extremes. Design and fabrication by Misco Fabricators, 1999 Guion St., Detroit 7, Michigan.

When metals cycle between 2400° F. and room temperature 6 times daily . . . they lose heart quickly.

Yet that . . . and corrosive furnace atmospheres to boot . . . is what equipment for heat treating Alnico magnets must withstand.

Until Inconel® trays and covers were tried, at General Magnetic Corporation, no material proved satisfactory. Now, with Inconel, six months or more of service is obtained.

These trays and covers were made by Misco Fabricators, who specialize in heat treating equipment. They use Inconel extensively where, as in this case, requirements are rigorous.

Inconel retains good strength at high temperatures. It also shows little or no effect from carburizing or nitriding furnace atmospheres. Then, too, it is readily fabricated and repaired.

These are the reasons you can expect a well designed piece of Inconel equipment to show low overall cost . . . and give little trouble. At very high temperatures, it often is the only practical material to use.

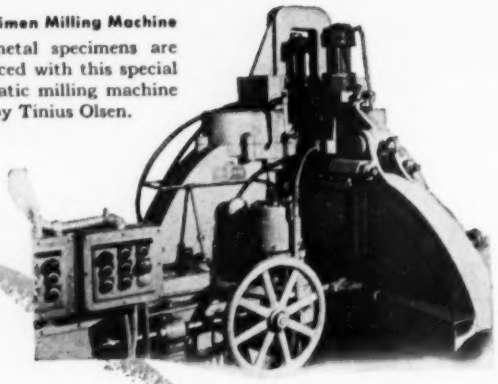
You'll find many suggestions on practical ways to make Inconel heat treating equipment in "Keep Operating Costs Down . . . When Temperatures Go Up." If you would like a free copy of this booklet, write:

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

Inconel Incoloy . . .

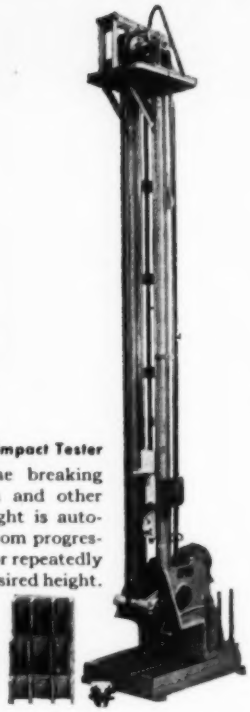
INCO TRADE MARK **Nickel Alloys**
for long life at high temperatures

Specimen Milling Machine
Standard metal specimens are mass produced with this special semi-automatic milling machine developed by Tinius Olsen.



how to take the special out of your "special" testing problem

Automatic Impact Tester
For determining the breaking point of gear teeth and other parts, a known weight is automatically dropped from progressively higher points or repeatedly dropped from any desired height.



. . . chances are that Olsen has already developed the specialized testing equipment you need.

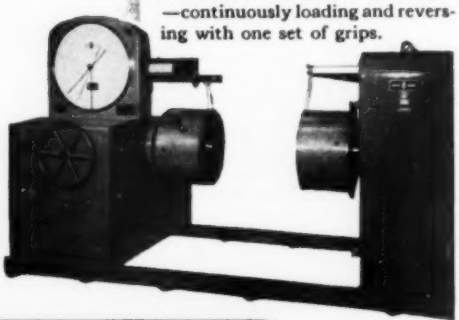
In addition to the industry-accepted Super "L" and Electomatic universal testing machines, *Olsen produces the most complete line of special purpose testing machines and accessories available.* The four machines illustrated are typical of the scores of the "special" machines that are an integral part of the standard Olsen line.

If you have a testing problem, contact Olsen. Our proved ability and experience are at your command.

Container Testing Machine
Even off-center loads are accurately weighed with this wide clearance Electomatic compression testing machine, which has unlimited stroke and positive testing speeds.



"Double" Torsion Testing Machine
Introducing a new twist in torsion testing, this Olsen machine weighs loads in both directions of rotation —continuously loading and reversing with one set of grips.



what's new in testing?

Many of the latest advances in testing equipment and techniques are featured in Tinius Talks, published semi-annually by Tinius Olsen. Copies of this informative publication will be sent upon request.

TINIUS OLSEN
Testing & Balancing Machines

TINIUS OLSEN TESTING MACHINE CO.
2030 Easton Road · Willow Grove, Pa.

Now . . .

You can produce MORE for LESS with

"ONE STOP" TOOLING SERVICE

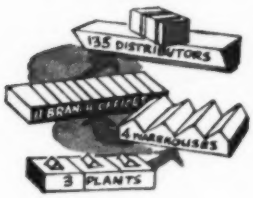


Profit, today, must come from production . . . with overhead, sales, labor, and material costs at constant or increasing high levels. The need to produce more product for the same money or the same volume of product for less money makes *tooling* the *key* to profit!

Only Firth Sterling can serve you so completely in solving the tooling problems that enable you to make production profits . . . for these six convincing reasons:



UNBIASED RECOMMENDATIONS Because Firth Sterling makes *both* steel and carbide tooling materials, you get completely unbiased recommendations. The exactly right tools or tooling materials will be matched to your production needs, resulting in better, faster, cheaper production.



UNLIMITED SELECTION *Only* Firth Sterling offers so many grades, styles and sizes of both steels and carbides from *one* source of supply . . . 16 High Speed Steels, 53 Tool and Die Steels, 6 High Temperature Alloys, 12 Tungsten Carbides embracing standard tools and tips, toolholders and inserts, dies, perforators, and "specials" *plus* Chromium Carbides, Stainless Specialties, Titanium Carbide Cermets, Firth Heavy Metal, and Zirconium!

EFFECTIVE NATIONAL DISTRIBUTION Three plants, 4 warehouses, 11 branch offices and 135 distributors strategically located in the manufacturing centers of the country assure readily accessible supply sources for all your tooling needs.



CONSTANT RESEARCH Continuing full-scale research with emphasis on product improvement, specialty steels, carbides, new metals and new methods assures you years-ahead tooling procedures when you make Firth Sterling your one-stop source of supply.



PACKAGED TOOL LINE The most complete line of packaged tools available comes in standard quantities, easy to handle, stock, identify and inventory . . . in both steel and carbide.



ONE SOURCE MAKES SENSE Yes, only Firth Sterling can so adequately provide one-stop, one-source-of-supply tooling service with its assurance of unbiased recommendations, simplified lower-cost ordering . . . resulting in better, faster, cheaper production. It makes sense, doesn't it? Ask Firth Sterling to analyze your tooling problems . . . to produce *more* for *less.*

Firth Sterling

—INC—

GENERAL OFFICES: 3113 FORBES ST., PITTSBURGH 30, PA.

OFFICES AND WAREHOUSES*: BIRMINGHAM CHICAGO* CLEVELAND DAYTON DETROIT* HARTFORD* HOUSTON LOS ANGELES* NEW YORK PHILADELPHIA PITTSBURGH WASHINGTON WESTFIELD, N.J.

M-297

PRODUCTS OF FIRTH STERLING METALLURGY

High Speed Steels
Tool and Die Steels
Stainless Specialties
High Temperature Alloys

Sintered Tungsten Carbides
Firth Heavy Metal
Chromium Carbides
High Temperature Cermets

Zirconium

Our NEW RareMeT Compound



is Now TWICE AS HEAVY

Years of experience with rare earth materials, constant research and application of our product assure you of the best results.

Our new RareMeT Compound is evidence of our progress. Now the new RareMeT Compound is twice as heavy, requires less handling and provides more uniform results.

Hot workability in many types of steels is being improved with small additions of this already established product. For example, in stainless steel, excellent results in both hot workability and increased yield have been obtained, as published in MCA's current literature and the trade magazines.

As recognized authorities in the application of Molybdenum, Tungsten, Boron, Cerium and its derivatives both as alloys and chemicals, MCA assures confidential and immediate response to inquiries.

WRITE TODAY FOR FURTHER INFORMATION

MOLYBDENUM

CORPORATION OF AMERICA

Grant Building **Pittsburgh 19, Pa.**

Offices: Pittsburgh, Chicago, Detroit, Los Angeles, New York, San Francisco
Sales Representatives: Edgar L. Fink, Detroit; Brumley-Donaldson Co., Los Angeles, San Francisco
Subsidiary: Cleveland Tungsten, Inc., Cleveland *Plants:* Washington, Pa., York, Pa.

MCA

MAKE *Truspec*

SCOVILL ALUMINUM SHEET

a Partner in your drive for *Lower Costs*



Here is a new and superior commercial Aluminum Sheet . . . now available in a wide range of standard wrought alloys . . . with these outstanding advantages for fabricators:

- NEW controlled uniformity of temper throughout each coil.
- NEW control over grain size spread and inherent directional properties.
- NEW uniform tolerances on width, thickness, length and edgewise straightness.
- Effective aid in minimizing "orange peel" effect and "earing."
- Extra long coils help reduce machine down-time on long runs.
- Clean, smooth surfaces.
- Temper and chemical tests on each shipment to assure meeting customers' requirements.

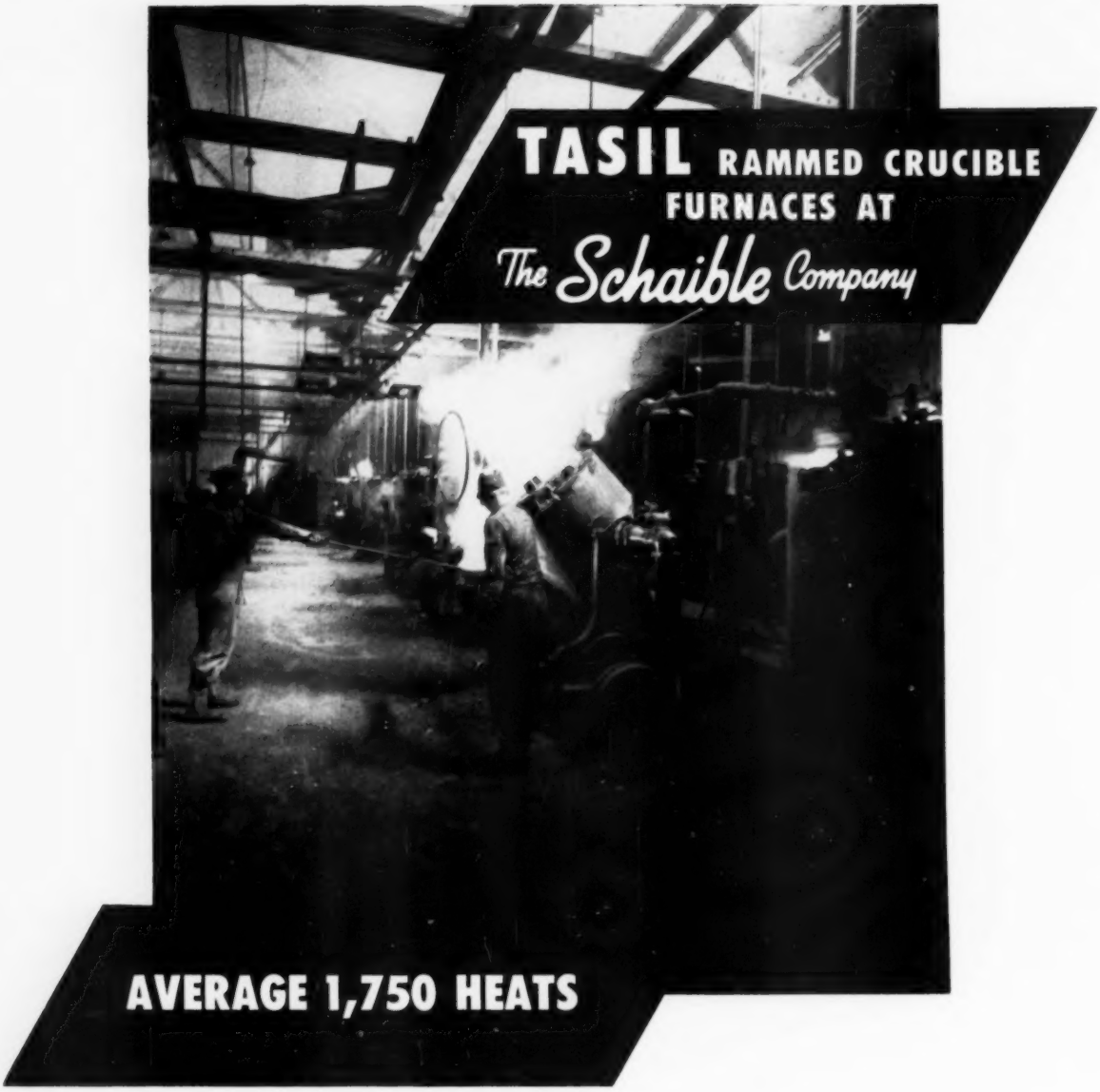
You will find that these important differences in Scovill's new TRUSPEC Aluminum Sheet add up to differences you can SELL in your fabricated aluminum products. Get in touch with us at once for full details.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone Waterbury 4-1171.

125C54

SCOVILL MILL PRODUCTS

BRASS ★ BRONZE ★ NICKEL SILVER ★ ALUMINUM



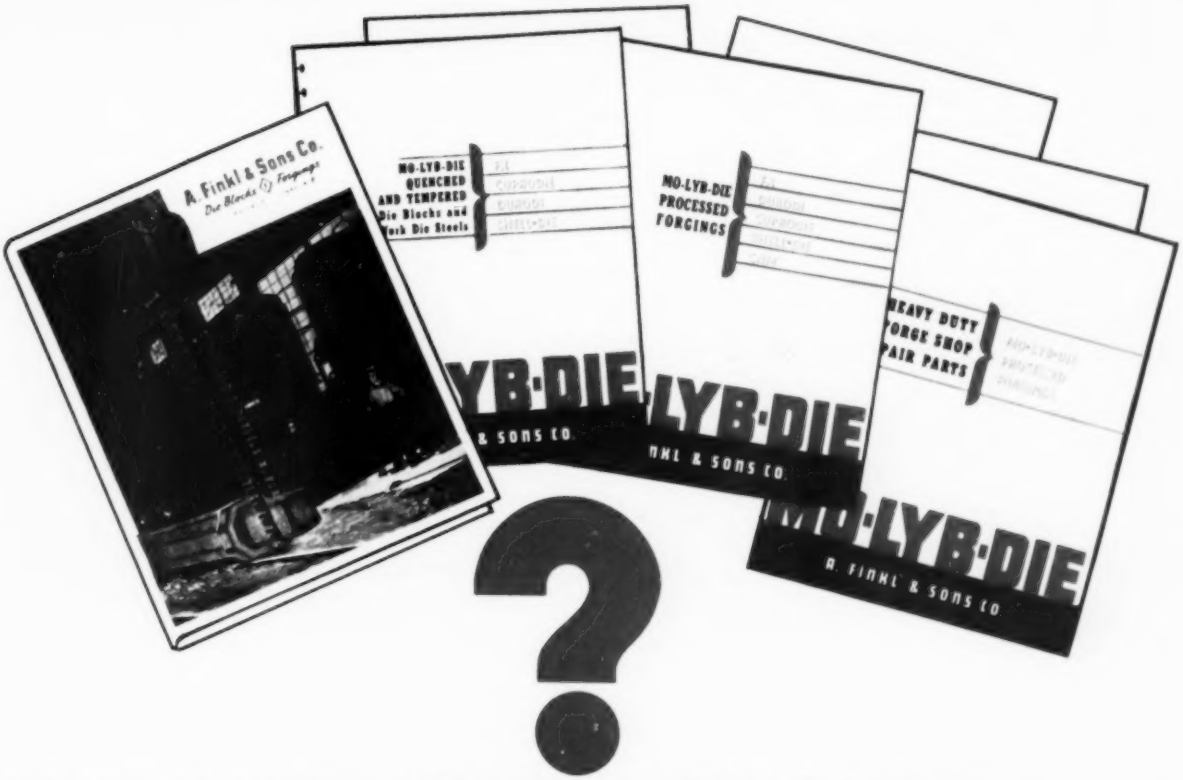
The Schaible Company, Cincinnati, Ohio, leading producer of plumbing and heating equipment, has standardized on Taylor Sillimanite #213 Ramming Mix for lining this battery of 17 #600-M Campbell-Hausfeld gas-fired crucible furnaces melting 700-pound heats—#275 crucibles. Tests have proved to Schaible that Taylor Sillimanite (TASIL) linings last longer, require less patching.

One TASIL rammed lining ran 2,051 heats of plumbing brass per lining. The average is approximately 1,750 heats. On a semi-continuous operation this means 1½ to 2½ years' service with a minimum of patching. This compares to 565 heats average for silicon carbide special shape linings with insulation backup. After considerable testing of other refractories, some cheaper, some more expensive, TASIL #213 Ramming Mix is the standard refractory lining.

TASIL works equally well in other types of crucible and barrel-type metal melting furnaces. Recommended for either gas or oil firing. Write for your free copy of Bulletin #315.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.



WHAT DO YOU WANT TO KNOW ABOUT

DIE BLOCKS and FORGINGS

How they are made? How they are tested? How to make dies last longer? How to heat treat? The many uses of forgings? This 92 page booklet tells all about die blocks and forgings. In addition there are over 20 pages of helpful tables and measures including a section on standard practices and tolerances for impression die forgings.

This booklet is offered free to users of die blocks and forgings to help in the selection of quality products . . . . what to look for and what to expect from your supplier.

Please send your request to the nearest Finkl office listed below on your company's stationery giving your name and position.

You can profit from our experience in the manufacturing of die blocks and forgings. The quality control in each step of processing from our own electric steel furnaces to the finished product shows in the field in greater performance and longer life. Call on Finkl for the finest in die blocks and forgings.

DETROIT 26: 2838 Book Bldg. WOodward 1-1315 • **CLEVELAND 14:** 1914 NBC Bldg. CHerry 1-2939 **PITTSBURGH 22:** 762 Gateway Center. ATlantic 1-6391 • **INDIANAPOLIS 5:** 132 East 30th Street. HICkory 4647 • **HOUSTON 1:** PO Box 1891. CAPitol 2121 • **ALLENTOWN:** 737 North 22nd Street. HEmlock 4-3333 • **ST. PAUL 1:** 445 Endicott Bldg. CEDar 1600 • **COLORADO SPRINGS:** 534 West Cheyenne Road. MElrose 2-0431 • **SAN FRANCISCO 5:** Monadnock Bldg. EXbrook 2-7018 • **SEATTLE 4:** 3104 Smith Tower. SENeca 5393 • **BIRMINGHAM:** PO Box 1606. 7-1603 • **KANSAS CITY 6:** 950 Dierks Bldg. HARrison 1060 • *Western warehouse* **LOS ANGELES 29:** 1001 North Vermont Avenue. NOrmandy 3-2141 • *Eastern warehouse* **EAST CAMBRIDGE 41:** 250 Bent Street. Elliot 4-7650

1879 1954 75th ANNIVERSARY

MANUFACTURERS OF THE LARGEST FORGINGS IN THE MIDDLE WEST

A. Finkl & Sons Co.

2011 SOUTHPORT AVENUE • CHICAGO 14

FORGINGS • DIE BLOCKS • ELECTRIC FURNACE STEELS

Johns-Manville announces the development of new **SIL-O-CEL 16L** *Insulating Fire Brick...*



Lompoc, California, where Johns-Manville mines and processes diatomaceous silica insulating materials

Combines outstanding physical and thermal properties for furnace service to 1600F

Check these properties of SIL-O-CEL 16L

Maximum service temperature	1600F, back-up or exposed
Approximate density	33-35 lb per cu ft
Transverse strength	60 psi
Cold crushing strength	350 psi
Linear shrinkage	0.7 percent at 1600F
Reversible thermal expansion	less than 0.1 percent at 1600F
Thermal conductivity (Btu in. per sq ft per F per hr at indicated mean temperatures)	0.92 at 500F 1.07 at 1000F 1.22 at 1500F

1—has less than 0.1% reversible thermal expansion at 1600F

2—provides high load-bearing strength

3—for direct exposure or back-up service

Here is a new development of Johns-Manville insulation and refractory research. Its exceptional characteristics provide important savings in furnace construction. Made of diatomaceous silica, Sil-O-Cel* 16L Insulating Brick is light in weight . . . has low thermal conductivity . . . high structural strength. And where furnace linings are subjected to severe heat shock or where high load-bearing properties are needed, Sil-O-Cel 16L offers outstanding performance.

Sil-O-Cel 16L is now available. Samples will be sent on request. Also available without obligation is Booklet IN-115A, which describes Sil-O-Cel 16L and other J-M Insulating Brick and Insulating Fire Brick for service to 3000F. Write Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Sil-O-Cel is a Johns-Manville registered trade mark

Replaces SIL-O-CEL Natural Brick

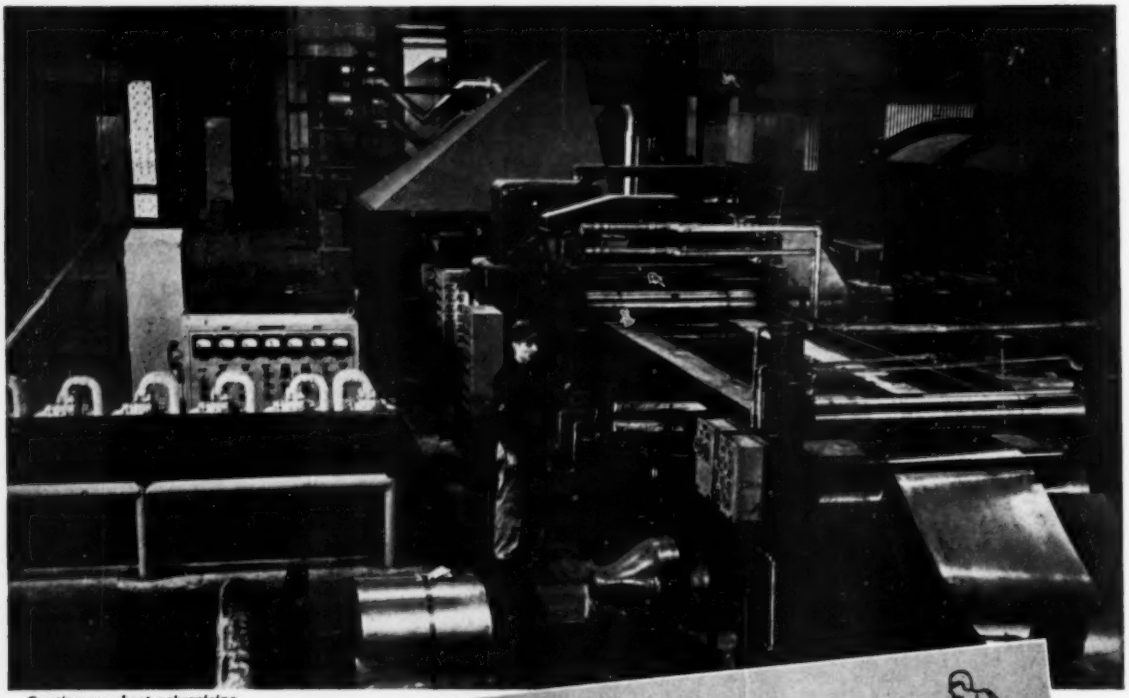
The development of Sil-O-Cel 16L Insulating Brick has resulted in the discontinuance of Sil-O-Cel Natural Brick. The outstanding properties of Sil-O-Cel 16L make it the ideal replacement for Sil-O-Cel Natural Brick for back-up use. In addition, the properties of Sil-O-Cel 16L Brick extend its use to exposed service applications.

JM

Johns-Manville *FIRST IN* INSULATION

MATERIALS · ENGINEERING · APPLICATION


Designed for
Lasting Beauty with
REVERE
ALUMINUM
More and more manufacturers of commercial products have turned to Revere Aluminum because of its high strength, workability and lasting beauty. And with Revere Aluminum they are assured of a fine, uniform quality.
Revere meets your requirements with a wide range of aluminum alloys in extruded shapes, coiled sheet, drawn tube, electrical bar and forgings. And for assistance with a specific problem, the Revere Technical Advisory Staff is ready to serve you.
For the best in aluminum or technical assistance . . . call Revere.
REVERE
ALUMINUM
REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N.Y.
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities.
SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS



Continuous sheet galvanizing.

Over 350,000 tons of Zn annually for "embalming"

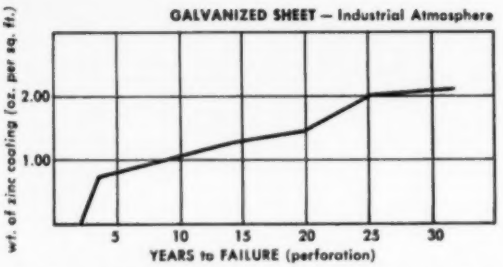


ONE OF the most persistent problems confronting the iron and steel industry is the prevention of corrosion; its persistence stems from the fact that we cannot rid ourselves of the agents which effect the corrosion without, at the same time, ridding ourselves of elements – air and water – which are essential to life itself.

Iron does not occur naturally in the metallic state, but only in combination with oxygen and other elements in the form of ore. The smelting of iron is essentially a process for removing the oxygen from the ore by the application of heat; while rusting is, in essence, the reversion of the metal to its natural state by recombination with the oxygen in the air. The rusting process, being electrochemical in character, is actually far more complicated since the moisture and impurities present in the air play a very important part. There is thus a close relationship between the processes connected with the preservation of organic tissue and the prevention of rust. However, while human beings stave off the decaying or "rusting" of their tissues by nutrition, no means have been developed for "feeding" or regenerating iron and, until such time, industry has adapted the ancient Egyptian practice of "embalming."

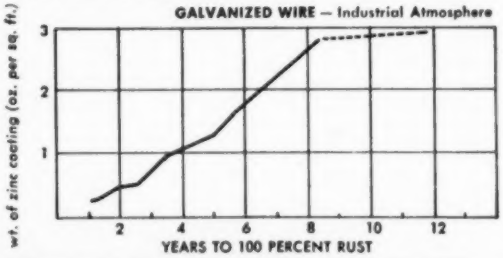
The most widely used method of "embalming" iron and steel products to prevent their decomposition is by galvanizing, i.e., zinc coating. The fact that, for many years, nearly 50% of all the zinc consumed annually in the United States is used for this purpose, is ample evidence of the firmly established position of the metal as industry's most effective "sacrificial" weapon in its unceasing combat with the ravages of rust.

ST. JOSEPH LEAD COMPANY
250 PARK AVENUE, NEW YORK 17, N.Y.

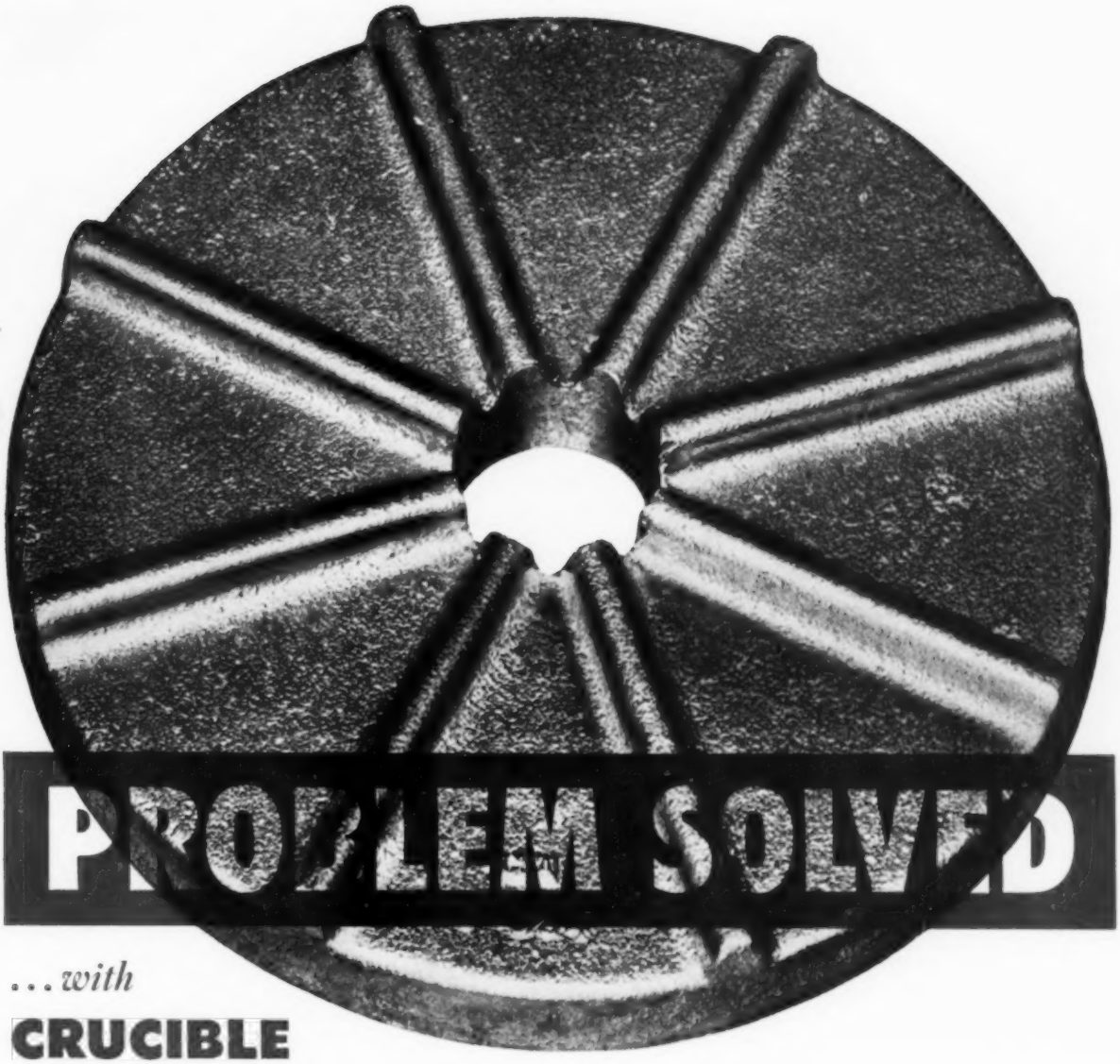


• "The most important factor in determining the lives of zinc coatings in industrial atmospheres is the weight of zinc applied." *from U.S. Bureau of Standards, Circular #80*

• The remarkable protective effect of zinc on iron is due to the fact that for electrochemical reasons corroding agents will attack zinc in preference to iron if the two are in contact. Rusting of iron does not occur even at scratches or cut edges of a galvanized coating so long as any zinc remains within about one quarter inch of the exposed iron surface.



ST. JOE *electrothermic* **ZINC** HIGH GRADE • INTERMEDIATE • PRIME WESTERN



. . . with

CRUCIBLE

stainless steel castings

A large shell manufacturer had a serious problem. Cast iron shell holders, used in the hardening furnaces where temperatures go up to 1600 F, burned out and crumbled. Frequent replacements and costly shutdowns were necessary.

The casting shown above (Crucible Type 309) proved the answer to the problem. This sand casting of heat-resistant stainless steel, and hundreds like it, are outperforming their iron predecessors . . . and seem headed for a practically limitless life.

It will pay you, too, to take full advantage of Crucible castings. They are available in a wide range of stainless, tool and special alloy grades, and to meet conditions of corrosion, high-temperature, wear or abrasion. And Crucible—leading producer of special steels—controls the steel used, from furnace to finished casting. You can be sure of sound, uniform castings of the highest quality when you *call Crucible.*



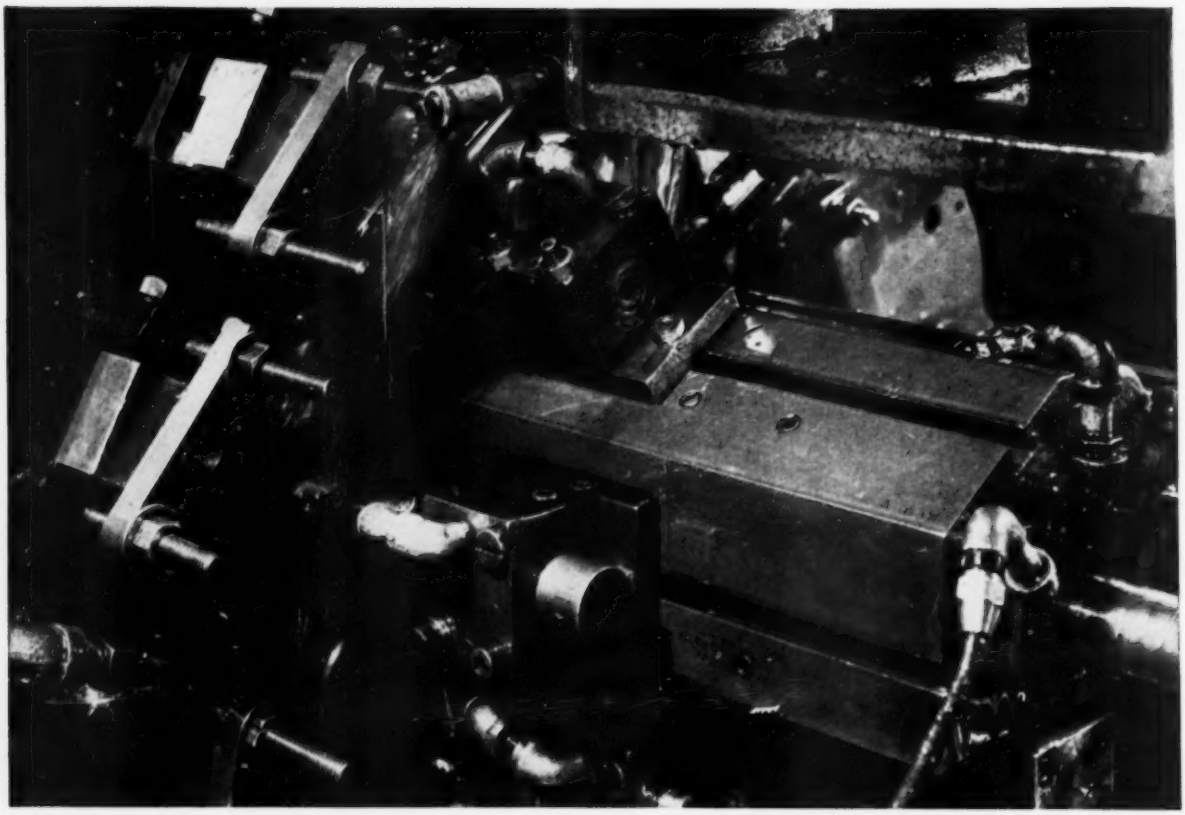
CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking

STAINLESS CASTINGS

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS



Are your automatics turning out what they could?

Let's say you've checked the machine itself. The tools. The setup. The feeds and speeds. And you find them O.K.

You may still be missing your peak production because of the steel you're using.

Many manufacturers have found that switching to Republic Cold Drawn Alloy Steels has given them the qualities they want in steel parts. And it's also given them the cost-cutting advantages that are built into high-speed automatics. Here's how it works.

Designers can make full use of Republic Cold Drawn Alloy Steel's high strength and uniform structure. Production men get the ideal combination of wearability and strength from the uniform hardenability and toughness of alloy steel.

And you get uniform machinability as well.

Republic's 3-D Metallurgical Service is ready to help you get the best out of Republic Cold Drawn Alloy Bars. A phone call to your nearest Republic District office may uncover the answers to some of your tough cost and production problems.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

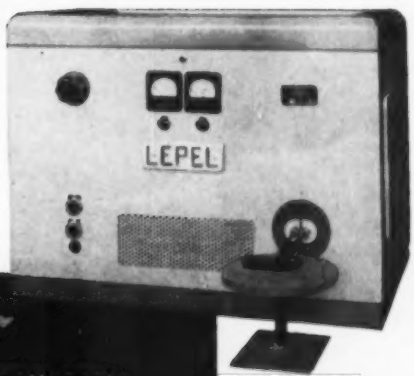
REPUBLIC *COLD DRAWN ALLOY STEEL BARS



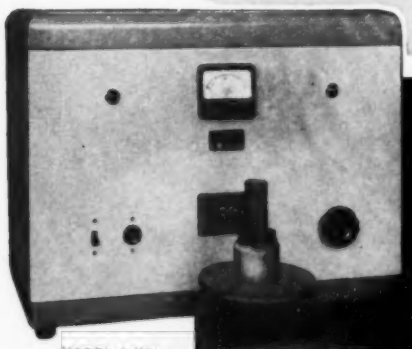
Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Bars, Wire, Pig Iron, Steel and Plastic Pipe, Bolts and Nuts, Tubing

Lepel's 3 new

LOW COST - PORTABLE
HIGH FREQUENCY
Induction
HEATING UNITS



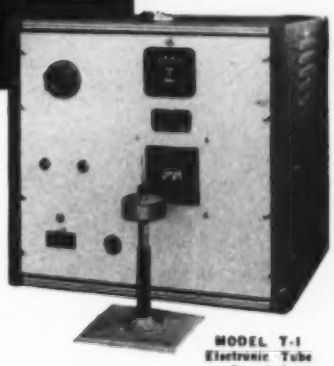
MODEL T-2½-I
Electronic Tube
Operated
$1620.
f.o.b. factory



MODEL 2 KW
Spark Gap Operated
$870.
f.o.b. factory

Ideal for

- Production Heating of small parts
- Research Laboratories
- Tool Rooms
- Machine Shops
- Educational Institutions



MODEL T-1
Electronic Tube
Operated
$885.
f.o.b. factory

The Lepel line of induction heating units represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating. With a background of half a century of pioneering electrical and metallurgical experience, the name Lepel has become the symbol of induction heating equipment embodying the highest standards of engineering achievement, dependable low cost operation and safety.

Amazing in its speed, Lepel equipment reduces the time required for hardening, annealing, stress relieving, brazing, soldering and melting from minutes to seconds. It performs these operations with a degree of precision and uniformity rarely attained through other processes.

LEPEL Electronic Tube GENERATORS available from 1 kw to 100 kw.
LEPEL Spark Gap CONVERTERS available from 2 kw to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages packed with valuable information on high frequency induction heating.

BRAZING



Permits widest choice of silver or copper brazing alloys from lowest to highest melting points. Ideal for brazing carbide tips.

HARDENING



Heat localized exactly where wanted at desired temperature. Ideal for gears, cams, bearing surfaces, cutting tools and other areas that are subject to wear.

SOLDERING



Speedily and neatly performs intricate soldering applications with or without the use of preformed rings.

ANNEALING



Ideal for annealing, stress-relieving, normalizing or pre-heating selected areas.

MELTING

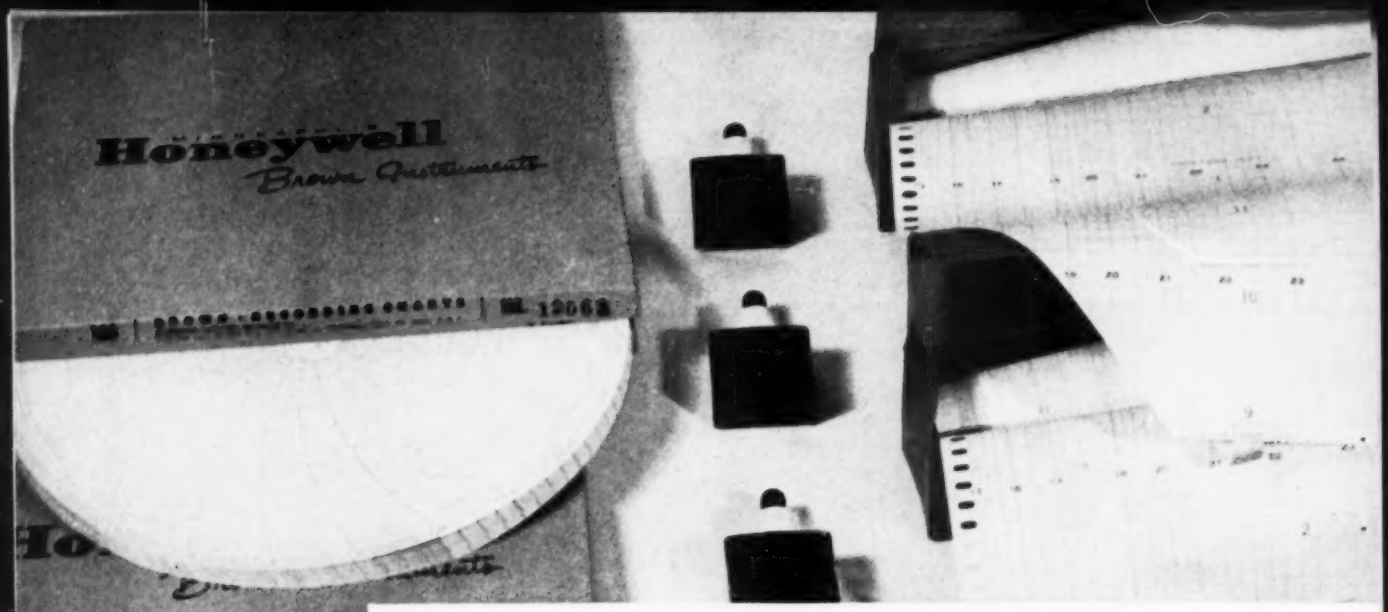


Readily melts quantities of ferrous and non-ferrous metals in either graphite or ceramic crucibles.

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.



LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.



NEW recorder charts!

NEW inks!

available through your HSM
HONEYWELL SUPPLIES MAN

Meet the brand new line of Brown recorder charts and inks . . . the finest "team" ever developed to give you the peak in recording performance on your Brown instruments.

The new strip and circular charts are made of the highest grade pulp, quality-controlled for perfect appearance and texture. They're given a special internal and external sizing to produce a superior writing surface that won't feather or strike through. Stretching and shrinking due to changes in humidity are practically eliminated.

The new inks are custom-made to write sharp, clear records on the new papers. They dry quickly . . . yet give minimum evaporation in the pen reservoir. A selection of brand new colors is available, including a deep black suitable for blueprint reproduction.

Ask your local Honeywell Supplies Man about these new papers and inks . . . and about the economical, convenient HSM Plan for purchasing pyrometer supplies. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA: Write for new Booklet, "The HSM Plan for Purchasing Pyrometer Supplies."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



Fast Service on your orders for charts, and other pyrometer supplies, is expedited by this teletype equipment at Honeywell stock headquarters.

Metal Progress

BULLETIN BOARD

THE BUYERS GUIDE FOR METALS ENGINEERS

NARACO FINISHING TIPS



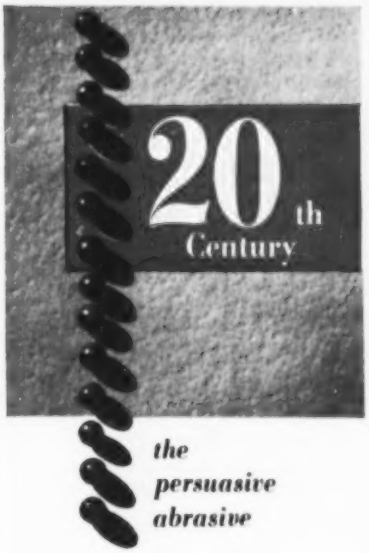


Chrome finishing for decorative hood ornaments—such as the "Rocket"—shown on this car is a plating problem . . . even to the experienced plater. NARACO'S know-how in engineering has answered this problem! They have designed an efficient rack, with accurately spaced robber bars, which produces a uniform chrome deposit free from any shading or burning.
You too can take a timely finishing tip from NARACO Plating Rack and Fixture Service by calling your nearest NARACO Plant—today!

NARACO

NATIONAL RACK CO. INC., 179-181 Madison Street, Paterson, New Jersey
IMPERIAL RACK CO. INC., 1109 E. Stewart Avenue, Flint, Mich.
AMERICAN RACK CO., 703 W. Root Street, Chicago, Ill.
INDUSTRIAL RACK CO., 3442 N. San Fernando Road, Los Angeles, 65, Cal

LIST NO. 14 ON INFO-COUPON PAGE 64



the persuasive abrasive

Whether your concern is castings, forgings or metal parts, make 20th Century *Normalized shot and grit a part of your straight-line production operation.

The high uniformity and greater durability of 20th Century *Normalized give you maximum efficiency, increased economy, and a quality product.

New catalog No. 1153 on request.

THE CLEVELAND Metal Abrasive CO.

836 East 67th Street • Cleveland 8, Ohio
Howell Works: Howell, Michigan

*One of the world's largest producers of quality shot, grit and powder – Hard Iron – Malleable (*Normalized) – Cut Wire – Cast Steel (Realsteel)*

*Copyrighted trade name

LIST NO. 2 ON INFO-COUPON PAGE 64

"Pur-Blac"

- Economical
- No Change in Dimension
- Corrosion Resistant
- Perfect Uniformity
- Non-Technical

The Black Oxide Finish That Penetrates Iron & Steel Surfaces

PURITAN MANUFACTURING CO.
WATERBURY, CONN.

LIST NO. 95 ON INFO-COUPON PAGE 64

RUST-LICK IN AQUEOUS SYSTEMS

Grade "C-W-25"

Non-flammable
Non-toxic
Aqueous Oily Film Protects Ferrous Parts for Long Periods Indoor Storage

Write for free sample and brochure
Specify Grade "C-W-25"

PRODUCTION SPECIALTIES, INC.
755 BOYLSTON STREET
BOSTON 16, MASS.

LIST NO. 121 ON INFO-COUPON PAGE 64



MANHATTAN

Abrasive Wheels — Cut-off Wheels

Finishing Wheels—Diamond Wheels

Custom-made for your specific material removal problems

Foundry Snagging—Billet Surfacing—Centerless Grinding

Cutting and Surfacing concrete, granite, and marble

"Moldiscs" for rotary sanders

Grinding and Finishing stainless steel welds

Bearing Race Grinding and Finishing

Finishing Tools and Cutlery

Cutting-off—Wet or Dry Bars, Tubing, Structurals, etc. Foundry Cutting—standard and reinforced wheels

Grinding Carbide Tipped Tools

•

Write to Abrasive Wheel Department

Raybestos-Manhattan, Inc.

MANHATTAN RUBBER DIVISION

92 TOWNSEND ST. • PASSAIC N. J.

LIST NO. 1 ON INFO-COUPON PAGE 64

Do you know the TECHNIC METHOD of Electroplating

RHODIUM?

Heavy rhodium electroplating—in thicknesses up to .001"—is now entirely practicable. Using Technic solutions and controlled equipment, you can impart the properties of pure rhodium to base metals.

Use of rhodium is recommended throughout industry, wherever extremely corrosive conditions are encountered. We can equip you to do low-cost electroplating with scientifically controlled results—better work at lower cost than you have achieved before. Without obligation, send us your problems for study.

TECHNIC INC.

Providence, Rhode Island, U. S. A.

JAckson 1-4200

THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD

LIST NO. 116 ON INFO-COUPON PAGE 64

HOW TO DO BRIGHT GOLD PLATING *without scratch brushing or buffing!*

GOLD

SILVER

RHODIUM

Write for complete details

Sel-Rex

BRIGHT GOLD PROCESS

FOR INDUSTRIAL and DECORATIVE USES

1. Exceptionally hard deposits — twice the hardness of conventional gold plating.
2. Operates at room temperature — requires absolute minimum control.
3. Excellent metal distribution and "throwing power."

SEL-REX PRECIOUS METALS, INC.

Dept. BB, 229 Main Street

Belleville 9, N. J.

LIST NO. 108 ON INFO-COUPON PAGE 64

WELDCO

FABRICATED MONEL PICKLING EQUIPMENT

• Hairpin Hooks • Sheet Crates

• Steam Jets • Chain

• Mechanical Bar, Tube and Coil Picklers

THE YOUNGSTOWN WELDING & ENGINEERING CO.

3721 OAKWOOD AVE. . . . YOUNGSTOWN, OHIO

LIST NO. 94 ON INFO-COUPON PAGE 64

RUST-LICK

IN AQUEOUS SYSTEMS

Grade "B"

FERROUS METAL PROCESSING

Eliminates . . .

Rust
Fire Hazards
Toxicity
Dermatitis
Degreasing

Write for free sample and brochure
Specify Grade "B"

PRODUCTION SPECIALTIES, INC.

755 BOYLSTON STREET

BOSTON 16, MASS

LIST NO. 105 ON INFO-COUPON PAGE 64

Avoid Plating Rejects by Getting Clean Metal Surfaces With PROMAT ACID ADDITIVE



Special Trial Offer $5.00 Postpaid

Promat acid additive is actually an accelerator—not an inhibitor. It assures complete and uniform removal of hot rolled or heat treat scale—rust—or oxide film.

TRY a one-gallon can of #7073 in your shop—DISCOVER the time-saving, money-making advantages *now!*

Send today for bulletins on the complete Swift line of metal finishing and treating compounds.

Swift INDUSTRIAL CHEMICAL CO. Canton Connecticut

LIST NO. 92 ON INFO-COUPON PAGE 64

Plan to Attend the

METAL SHOW

Chicago

November 1 to 5

1954

today's **wonder drug** for industry

NOW...the greatest cost-saving, labor-saving, FINISHING DEVELOPMENT in a decade!

Make expensive time-consuming operations like filing, grinding, polishing, blasting, buffing a thing of the past with New Amazing SUPERSHEEN SPEED FINISHING.

It absolutely does away with costly hand deburring and other hand operations requiring the use of large quantities of expensive materials and costly skilled labor.

A single unit replaces from 2 to 12 men. Savings up to 95% on almost ALL types of parts with absolute uniformity, fewer rejects, finer finishes.

Investigate today!



Write for NEW FREE, 52-page Catalog

DEPT. J-7

ALMCO *Supersheen*

AMERICA'S LARGEST MANUFACTURER OF ADVANCED BARREL FINISHING EQUIPMENT - MATERIALS AND COMPOUNDS

ALBERT LEA, MINNESOTA

LIST NO. 75 ON INFO-COUPON PAGE 64

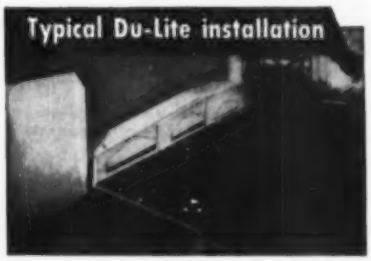
On any steel blackening problem

DEPEND on DU-LITE for a Superior Finish



Courtesy The Poly Choke Co.

Du-Lite gave this part with its complicated knurls, slots, threads, etc. a fine rust-resistant durable black finish. It is typical of many other parts, small and large, which have been black oxidized by Du-Lite for many years. Moreover, Du-Lite meets most individual and government specifications including 57-0-2C for Type III Black Oxide finish.



Du-Lite installations are simple, compact, easy to operate. Du-Lite equipment can be tailored to fit production requirements on all types of jobs with a maximum of speed and economy. Du-Lite also makes a complete line of cleaners, strippers, wetting agents, passivating agents, rust preventatives, burnishing compounds etc. for any metal finishing application.

See your nearest Du-Lite Field Engineer or write for more information.

DU-LITE CHEMICAL CORP.
MIDDLETOWN, CONN.

Rush information on your metal finishing products.

Name .....
Company .....
Address .....
City ..... Zone ..... State .....

Du-Lite
METAL FINISHING SPECIALISTES

LIST NO. 103 ON INFO-COUPON PAGE 64

BASKETS

for all industrial requirements

for de-greasing — pickling
anodizing — plating
materials handling
small-parts storage

of any size and shape — any ductile metal

by THE C. O. JELLIFF MFG. CORP.

WIRE PRODUCTS SINCE - 1880

28 Pequot Road
Southport, Conn.

LIST NO. 91 ON INFO-COUPON PAGE 64

Inspection Demagnetizing or Sorting PROBLEMS? SOLVED with

MAGNETIC ANALYSIS MULTI-METHOD EQUIPMENT

Electronic Equipment for non-destructive production inspection of steel bars, wire rod, and tubing for mechanical faults, variations in composition and physical properties. Average inspection speed 120 ft. per minute.

Over 50 steel mills and fabricators are now using this equipment.

MAGNETIC ANALYSIS DEMAGNETIZERS

Electrical Equipment for rapid and efficient demagnetizing of steel bars and tubing. When used with Magnetic Analysis Multi-Method Equipment, inspection and demagnetizing can be done in a single operation.

MAGNETIC ANALYSIS COMPARATORS AND METAL TESTERS

Electronic Instruments for production sorting both ferrous and non-ferrous materials and parts for variation in composition, structure and thickness of sheet and plating.

MAGNETIC ANALYSIS MAGNETISM DETECTORS

Inexpensive pocket meters for indicating residual magnetism in ferrous materials and parts.

For Details Write: "THE TEST TELLS"

MAGNETIC ANALYSIS CORP.

42-44 Twelfth St., Long Island City 1, N. Y.

LIST NO. 51 ON INFO-COUPON PAGE 64

Alexander

SHEET METAL TESTER

For Erichsen Test



Determines workability of ferrous, non-ferrous and fine metal sheets and strips to point of fracture. Reading—accurate to 0.0004" . . .

Write for Catalog

J. ARTHUR DEAKIN & SON

150-28 Hillside Ave. • Jamaica 32, N. Y.

LIST NO. 89 ON INFO-COUPON PAGE 64



If you want to perform Tensile or Brinell testing operations quickly and simply—*contact*

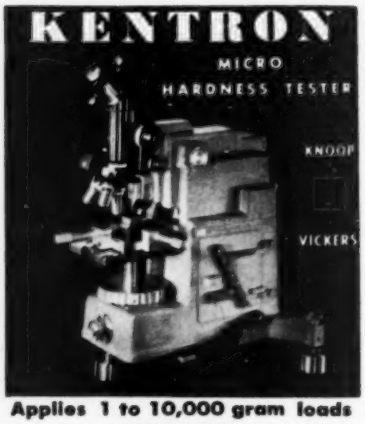
Detroit Testing Machine Company

9390 Grinnell Ave. • Detroit 13, Mich.

LIST NO. 54 ON INFO-COUPON PAGE 64

KENTRON

MICRO HARDNESS TESTER



Applies 1 to 10,000 gram loads

Write for Bulletin

Kent Cliff Laboratories Div.

The Torsion Balance Company

CLIFTON NEW JERSEY

LIST NO. 53 ON INFO-COUPON PAGE 64



ALL TYPES OF LABORATORY FURNACES BY

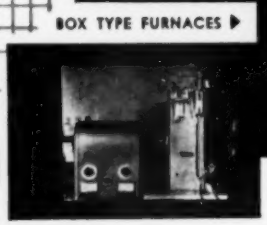
Boder

Thermocouple Checking
Automatic Type
Tube Types—2000-5000° F.
Box Types—2000-3000° F.
Heat Treating
Salt Bath Tempering
Melting by Carbon Arc
Metallurgical Experiments
Atmosphere Annealing
Powder Metallurgy
Hardenability Test
Combustions
Carbon & Sulfur Det.
High Frequency Fusion

HIGH FREQUENCY COMBUSTION UNITS



BOX TYPE FURNACES ▶





You tell Boder what you need

MANY TYPES OF TUBE FURNACES

BODER SCIENTIFIC COMPANY

719 LIBERTY AVE., PITTSBURGH 22, PA.
PHONE: ATLANTIC 1-5525

LIST NO. 55 ON INFO-COUPON PAGE 64



MERIAM
MANOMETERS

U-TYPE • WELL TYPE • DUAL TUBE

FLOW METERS
DRAFT GAUGES

For measuring pressure, vacuum and differential pressure of liquids and gases. Also a complete line of accessories.

ASK FOR CATALOG C-12

THE MERIAM INSTRUMENT CO.
10932 MADISON AVE.
CLEVELAND 2, OHIO

U-TYPE MANOMETER

LIST NO. 48 ON INFO-COUPON PAGE 64

ULTRASONICS

for rapid, accurate, non-destructive
THICKNESS MEASUREMENTS from oneside
and accelerated METAL CLEANING

VIDIGAGE Automatic Thickness Tester
Direct-Reading 21" Cathode-Ray Tube. Infinite Ranges 2:1, as selected, between 0.015" and 6" of steel or equivalent. Accuracy 0.1%—1.0% according to use.

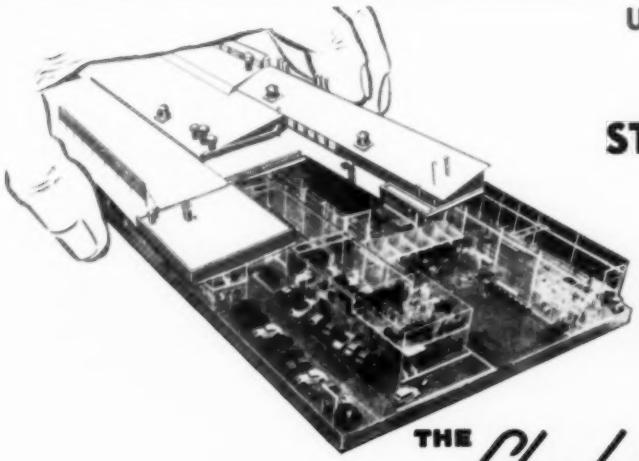
AUDIGAGE® Portable Thickness Testers
Battery-Operated. Ranges 0.020"-4" and 0.060"-12" of steel or equivalent

SONOGEN Ultrasonic-Power Generator
for Metal Cleaning and other Industrial uses.

BRANSON INSTRUMENTS, inc. electronics development production
439 FAIRFIELD AVE · STAMFORD · CONN.

Literature on Request

LIST NO. 81 ON INFO-COUPON PAGE 64



UNDER ONE ROOF . . .

at LAKESIDE
STEEL IMPROVEMENT

Your most comprehensive, complete scientific steel treating services

Electronic Induction Hardening, Carbonitriding, Flame Hardening, Heat Treating, Bar Stock Treating and Straightening (mill lengths and sizes), Annealing, Stress Relieving, Normalizing, Pack, Gas or Liquid Carburizing, Nitriding, Speed Nitriding, Aerocasing, Chapmanizing, Cyaniding, Sand Blasting, Laboratory Physical Testing.

THE Lakeside Steel Improvement Co.
5418 LAKESIDE AVE., CLEVELAND 14, OHIO HENDERSON 1-9100

LIST NO. 43 ON INFO-COUPON PAGE 64

JUST PUBLISHED . . .



THE STORY OF MALCOMIZING

(for surface hardening stainless steels)

what it is . . what it does . . how it works . . how you can use it.

Write today for your copy of this 24-page booklet. Specific subjects discussed include . . . pretreating the steels . . . selective Malcomizing . . . case depth . . . wear resistance . . . corrosion resistance . . . passivation of Malcomized steels.

A special "case history" section shows how nationally known manufacturers are specifying Malcomizing for the surface hardening of stainless steels.

Lindberg Steel Treating Co., serving industrial America from coast to coast, with plants in Rochester, Chicago, St. Louis and Los Angeles, is now licensed to Malcomize for its customers. For particulars call your nearest Lindberg plant.

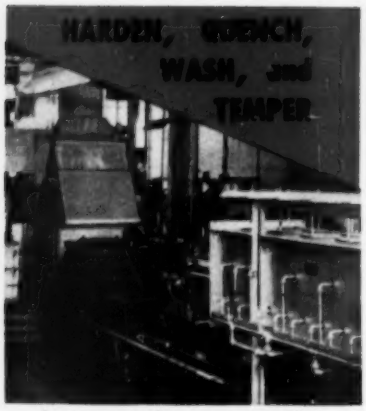
LINDBERG STEEL TREATING COMPANY

Melrose Park (Chicago), Illinois, Phone: Fillmore 6-6600; St. Louis 15, Missouri, 650 S. Taylor Avenue, Flanagan 2-6200; Los Angeles 11, 5710 South Soto Street, Phone: ANgelus 3-4141; Rochester 11, 630 Buffalo Road, Phone: Webster 5815.

CHICAGO • LOS ANGELES • ROCHESTER • ST. LOUIS

LINDBERG STEEL TREATING CO.

LIST NO. 38 ON INFO-COUPON PAGE 64



in one continuous operation

AUTOMATICALLY

Parts are conveyed automatically through 2 gas-fired hardening furnaces and into the quench tanks, from which the lines converge for direct conveyance to the **METALWASH** Spray Washer, where quenching oil is removed prior to tempering.

The **METALWASH** Spray Washer conveys the work directly into the continuous tempering unit. Combination washing and tempering machines also available.

Write today for information about the **METALWASH** way to *Heat, Quench, Wash* and *Temper* AUTOMATICALLY.

METALWASH
Quench Tanks and Tempering Units ®
WASHING PICKLING DRYING
PHOSPHATIZING DEGREASING

METALWASH MACHINERY CORPORATION
908 North Avenue, Elizabeth 4, N. J.
In Canada, Canefco, Ltd., Toronto, Ontario

LIST NO. 117 ON INFO-COUPON PAGE 64

CIRC-AIR

HEAT TREATING FURNACES

for
Every Heat Treating Process

★

CONTROLLED ATMOSPHERES

★

DIRECT FIRED

★

CIRC-AIR DRAW FURNACES

★

CIRC-AIR NICARB
(CARBONITRIDING)

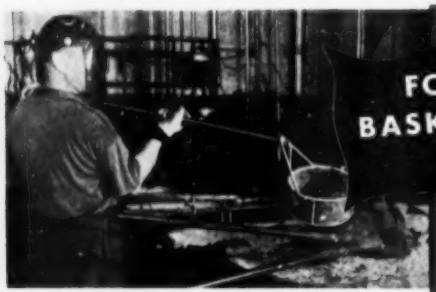
Specially Engineered for Your Particular Needs

•

GAS • OIL • ELECTRIC

INDUSTRIAL HEATING EQUIPMENT COMPANY
3470 Fremont Pl. • Detroit 7, Mich.

LIST NO. 19 ON INFO-COUPON PAGE 64



Style #13 in salt hardening bath application.

FOR ALL YOUR BASKET and FIXTURE NEEDS . . .

Call Wiretex

Wiretex has the facilities to serve your every need. Small, large, standard or custom built. To resist cold, heat, abrasion or corrosion. In every weave, metal and alloy. Prove it to yourself—send for the most complete catalog ever published.

BASKETS • RETORTS
MUFFLES • GRIDS
SCREENS • RACKS
for Quenching, Carburizing, Salt Bath, Dry Heat Applications, etc.

Representative Inquiries Invited.

Specialists in Processing Carriers Since 1932

Wiretex mfg. co.
5 Mason St., Bridgeport 5, Conn.

LIST NO. 114 ON INFO-COUPON PAGE 64

HERE'S HELP for your engineer-recruitment problem

Engineers' Joint Council and The Advertising Council offer free, expert help to advertisers promoting engineering as a career.

A booklet has been prepared by The Advertising Council in cooperation with the Engineers' Joint Council to help you in recruiting engineers for the future.

1. It tells you what the problem is and the important part you can play in solving it.
2. It outlines the advantages of an engineering career to help your company develop advertising appeals.
3. It informs you as to the current activities of industry in the education and recruitment of engineers.
4. It offers specific suggestions as to what you can do (from present manpower).
5. It provides material that you can use in your own local and national programs.

Many companies are using this booklet today. They say that it helps in orienting their engineer-recruitment advertising to industry-wide recruitment programs. Send for the booklet now. Address: The Advertising Council, Inc., 25 West 45th St., New York 36, N.Y.

This space contributed by American Society for Metals

INDUSTRIAL FUEL BURNING EQUIPMENT..

Designed FOR YOUR SPECIFIC REQUIREMENTS

- Motor-Mix Burners
- Model DA Mixers
- Western Safety Valves
- Injector-Mix Burners
- Flame Retention Nozzles
- Accessories
- Inspirator-Mix Burners
- Blowers
- Multiport Burners
- Custom Built Equipment

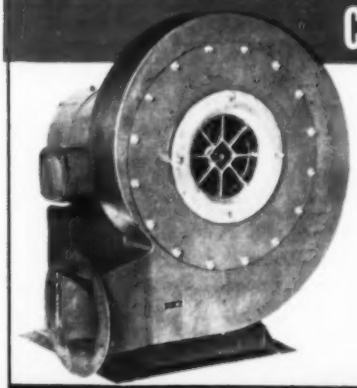
Free descriptive literature on request

WESTERN PRODUCTS, Inc.

General Office New Castle, Ind. — 549 W. Washington Blvd. Chicago 6, Ill.

LIST NO. 93 ON INFO-COUPON PAGE 64

Combustion Air Blowers



Single Stage
8 oz. to 20 oz. Pressures

- Designed to meet your capacity and pressure requirements.
- Maximum Efficiency — power consumption is proportional to air volume delivery
- Constant Pressures assured through properly designed case, air inlet and impeller

Write for Bulletin 100-53

Manufactured by WESTERN PRODUCTS, INC.
NEW CASTLE, IND.

LIST NO. 115 ON INFO-COUPON PAGE 64

Upton

. . . . OFFERS
the most advanced
Salt Bath Furnaces
FOR . . . .

BATCH TYPE WORK

o

CONVEYORIZED TYPE WORK

o

ALUMINUM BRAZING

o
o o
o

UPTON ELECTRIC FURNACE CO.
16808 Hamilton Avenue
Detroit, Michigan
Phone: Diamond 1-2520

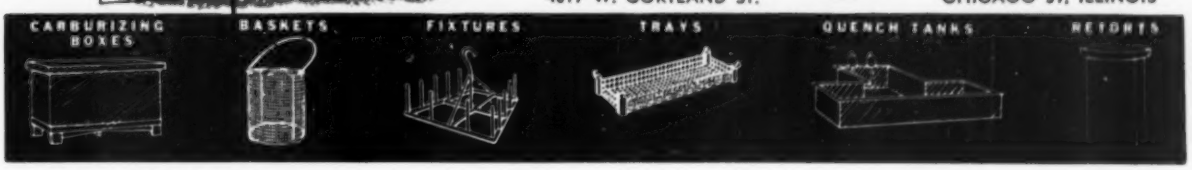
LIST NO. 29 ON INFO-COUPON PAGE 64

YOU Name it... WE'LL Supply it!

We make containers and fixtures of all types— for handling parts in heat treating, quenching, pickling, washing and anodizing operations. If what you need isn't shown in our catalog, we'll design and build it for you.

REPRESENTATIVES IN PRINCIPAL CITIES

Stanwood Corporation
4817 W. CORTLAND ST. CHICAGO 39, ILLINOIS



LIST NO. 12 ON INFO-COUPON PAGE 64

3 SIMPLE STEPS... TO SOLVE ALL YOUR HEAT TREATING PROBLEMS!



Coat piece with Phoenix Brand NON-SCALING COMPOUND, a dry, easy-to-handle powder.



Harden or anneal piece as normally required — powder forms protective coating completely sealing piece from air.



If necessary, boil in plain water to remove protective coating. Coating comes off quickly, easily—

giving you a bright scale-free, pit-free surface like

THIS . . . not THIS —



EVERY TIME!

Save TIME! Save MONEY!
Send for a trial order TODAY!
— Satisfaction guaranteed —

2 lb. can	—	$6.00
5 lb. can	—	$15.00
15 lb. can	—	$41.25
25 lbs. or more	—	$2.50 per lb.

ORDER TODAY FROM YOUR LOCAL DISTRIBUTOR OR WRITE

THE PARKER STAMP WORKS, Inc.
ESTABLISHED 1871
HARTFORD, CONNECTICUT

LIST NO. 120 ON INFO-COUPON PAGE 64

Expand Your Plant Potential

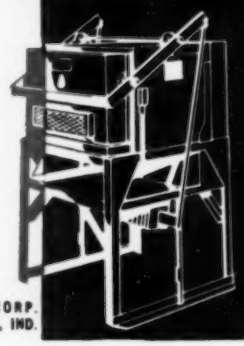
WITH Cooley ELECTRIC HEAT TREATING FURNACES

fast . . . inexpensive way to expand your plant facilities. Choose from 27 Models.



For Instance:

1. You save time and money by keeping heat treat jobs for small parts in plant.
2. It's easy to establish a new department at small cost in proportion to benefits which result.
3. Cooley heat treat furnaces pay for themselves through savings in time and subcontracting costs.
4. Heat treat operations are easily performed with Cooley designed furnaces.



Write now for Catalog giving complete details.

Cooley ELECTRIC MANUFACTURING CORP.
38 SO. SHELBY ST. • INDIANAPOLIS, IND.

LIST NO. 87 ON INFO-COUPON PAGE 64

Spotlighting
DETROIT'S BETTER
HEAT TREATER



OFFERING FACILITIES FOR:

1. **ALUMINUM**—CAP. 500,000# PER MO.
2. **MINUTE PARTS** TO 2-TON DIES
3. **BRIGHT HARDENING** OF STAINLESS STEEL

ALL TYPES OF HEAT TREATING CAN BE DONE BETTER BY

STANDARD STEEL TREATING CO.
3467 LOVETT AVE. DETROIT 10, MICH.
Phone TAshmoo 5-0600

LIST NO. 40 ON INFO-COUPON PAGE 64

DEMPSEY FURNACES

GAS, OIL AND ELECTRIC
BATCH • CONTINUOUS

ATMOSPHERIC - RECIRCULATING -
PUSHER — ROTARY HEARTH —
CONVEYOR — RADIANT TUBE — POT
CAR-BOTTOM - ALUMINUM REVERBS.

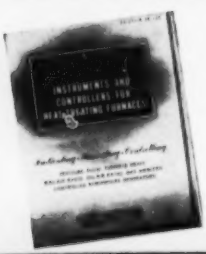
"Tailored by Dempsey"

DEMPSEY FURNACE

DEMPSEY INDUSTRIAL FURNACE CORP.
Springfield 1, Mass.

LIST NO. 79 ON INFO-COUPON PAGE 64

Instruments and Controllers for heat treating furnaces



A complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.).

Hays complete line of draft gages, flow gages and meters (for high and low pressure gases and liquids), portable gas analyzers and automatic CO_2 recorders are covered.

Write for bulletin 51-750-51

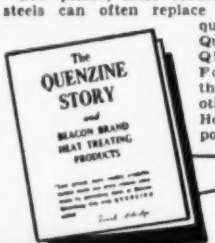
THE HAYS CORPORATION
Michigan City 26, Indiana

LIST NO. 30 ON INFO-COUPON PAGE 64

FREE

the QUENZINE STORY

Low priced, more readily available carbon steels can often replace alloy steels when quenched in Beacon Quenching Oils with QUENZINE added. For information on this new additive and other Beacon Brand Heat Treating Compounds write to . . .



KELCO

ALDRIDGE INDUSTRIAL OILS, Inc.
3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 29 ON INFO-COUPON PAGE 64

STEELWELD Bending Presses and Shears

Built for Heavy-Duty Long-Life Service



Steelweld machines have an enviable reputation throughout the United States and the world for their ease of operation and low-maintenance performance. Complete line for metal from light gauge to 1¼" and lengths to 24'-0". Representatives in all principal cities.



For Press data write for Catalog No. 2010.

For Shear data write for Catalog No. 2011.

The Cleveland Crane & Engineering Co.

5952 East 281 Street — Wickliffe, Ohio

LIST NO. 59 ON INFO-COUPON PAGE 64

ENGINEERING ALLOYS

by N. E. Woldman

This up-to-the-minute book lists over 19,000 alloys by trade name and gives their properties, compositions and typical applications. All important commercial alloys are shown.

1056 pages of valuable information, generous index and tables of manufacturers and the trade names of their products.

Price, $15.00

AMERICAN SOCIETY FOR METALS
7301 Euclid Ave. Cleveland 3

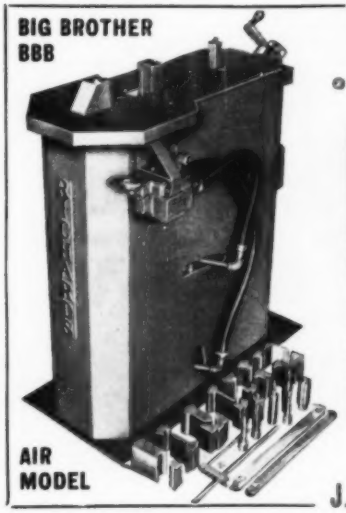
FROM BLANK TO FINISHED PART IN ONE OPERATION by SCHNELL PROCESS *of Deep Draw Dies*

On half tank sections formerly requiring three drawings and two annealing operations with scrap running as high as 50%!! The Schnell process reduced scrap loss to 1% or less . . . and production increased tremendously. Other advantages include better metallurgical properties, less metal distortion and a more uniform wall thickness. Whatever your stamping, drawing or die problem may be, there is a Schnell process for doing the job faster, more efficiently and less expensively. Schnell has complete engineering and plant facilities. Write for information on how you too may eliminate operations and reduce production costs.

SCHNELL TOOL & DIE CORP.
SALEM, OHIO

LIST NO. 118 ON INFO-COUPON PAGE 64

BIG BROTHER BBB



AIR MODEL

Multiform Benders Produce Without Special Tooling

● SAVE ON SET UP TIME ● REDUCE PRODUCTION TIME ● ELIMINATE SPECIAL TOOLING ● FOR BENDING ALL KINDS OF MATERIAL UP TO ¼" x 4"

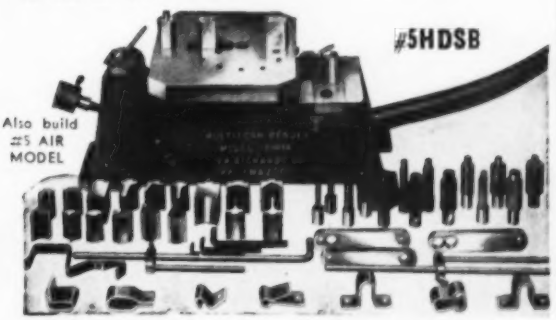


Illustrated above are a few of the many forms that can be produced efficiently on the Multiform Bender, using the standard tooling.

WRITE TODAY FOR FULL INFORMATION

#5HDSB

Also build #5 AIR MODEL



J. A. RICHARDS CO. • 913 N. Pitcher St. • Kalamazoo, Michigan

LIST NO. 107 ON INFO-COUPON PAGE 64

Send for your FREE Sample Tube of this Amazing New Lubricant

Molylube ANTI-SEIZE



Prove to yourself its extraordinary performance

Molylube Anti-Seize is a highly concentrated *non-melting* molybdenum disulphide grease having the phenomenal capacity to prevent galling and seizing at bearing pressures well over *100,000 pounds per square inch.* It has excellent lubricating qualities at low temperatures and elevated temperatures up to 750°F.

BEL-RAY COMPANY, INC.
MADISON, NEW JERSEY

LIST NO. 111 ON INFO-COUPON PAGE 64

Cut Costs With

FREE

Cutting Oil Chart

Use this *free* cutting oil chart as a handy guide to production costs and to more efficient machining operations.
Steel and nonferrous metals are charted with the proper cutting oil for many applications. Shows you how to use lubricants, sulphurized or compounded with extreme pressure additives, for all operations.

KELCO

ALDRIDGE INDUSTRIAL OILS, Inc.
3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 100 ON INFO-COUPON PAGE 64

WRITE, WIRE or PHONE FOR YOUR CATALOG Today



BOLTS & CAP SCREWS
SOCKET SET & CAP
NUTS, WASHERS
MACHINE SCREWS
SHEET METAL SCREWS
WOOD SCREWS
PIPE FITTINGS

Star STAINLESS SCREW CO.
ARmory 4-1240
218 Union Avenue • Paterson 2, N.J.
Direct NEW YORK Telephone: WI 7-9041

LIST NO. 4 ON INFO-COUPON PAGE 64

Prove it!

Prove to your own satisfaction that the MOLYKOTE line of industrial lubricants is one of the most spectacular contributions to metal progress in many decades. Send for free literature today . . . and then order a trial supply.

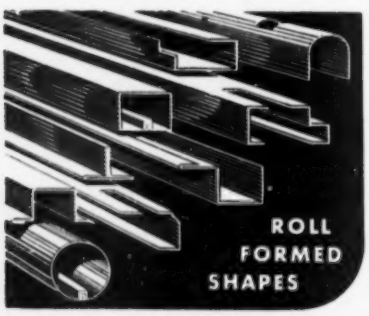
MOLYKOTE®
INDUSTRY'S MOST VERSATILE LUBRICANT

The tremendous lubricity of MOLYKOTE depends on the unique molecular structure of the compound. Read the story behind its development and the jobs it can do better than any other lubricants.

Send for free catalog today!

THE ALPHA CORPORATION
Greenwich, Conn.

LIST NO. 110 ON INFO-COUPON PAGE 64



Reduce your assembly problems and costs. Our shapes continuously formed, with high degree of accuracy, from ferrous or nonferrous metals. Write for Catalog No. 1053.

ROLL FORMED PRODUCTS CO.

MAIN OFFICE AND PLANT
3761 OAKWOOD AVE. • YOUNGSTOWN, OHIO

LIST NO. 101 ON INFO-COUPON PAGE 64

ask **SESSIONS**
HOW
STAMPED ASSEMBLIES
SAVE TIME & MONEY

Send samples or prints for quotations on special stampings and sub-assemblies.



J. H. SESSIONS & SON

291 RIVERSIDE AVENUE • BRISTOL, CONN.

LIST NO. 119 ON INFO-COUPON PAGE 64

Plan to Attend
the
METAL SHOW
Chicago
November 1 to 5
1954

CENTRIFUGAL CASTINGS...

Better
for most castings
Best
to prevent gas and liquid leaks

For details, write for booklet.
American Non-Gran Bronze Co.,
Berwyn, Pa.



NON-GRAN

LIST NO. 3 ON INFO-COUPON PAGE 64

Metal Progress is now in its Second year as one of our clients

Roy Eastman

The Eastman Editorial Research Service is a critical and advisory service to publishers for the sole purpose of developing and maintaining better readership.

Exclusive to one publication in a field.

Use of the Eastman service by Metal Progress is an implied guarantee to its readers of continuing editorial progress.

The Eastman Research Organization
500 5th Avenue • New York 36, N. Y

GET A BID FROM

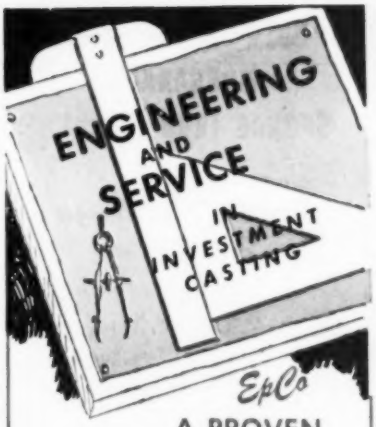
HOOVER

SPECIALISTS IN THE FIELD OF
Die Castings
SINCE 1922
Aluminum and Zinc

HOOVER

THE HOOVER COMPANY
Die Castings Division
North Canton, Ohio

LIST NO. 74 ON INFO-COUPON PAGE 64



EpCo

A PROVEN DEPENDABLE SOURCE
FOR BETTER GRADE INVESTMENT CASTINGS IN FERROUS AND NON-FERROUS METALS



INVAR CASTING Special Feature — Nickel content held to 35% minimum — 36% maximum

STAINLESS STEEL PART for milk bottling unit formerly machined from solid stock. Only finish operations required are reaming small dia. of counterbored hole and drilling and tapping for set screw.



ENGINEERED PRECISION CASTING CO.

MORGANVILLE, N. J.

LIST NO. 4 ON INFO-COUPON PAGE 64

A CABLE SPLICED IN 10 SECONDS!



ERICO PRODUCTS, INC.
Complete Arc Welding Accessories
2070 E. 61st Place, Cleveland 3, Ohio
Write for Caddy Catalog

LIST NO. 71 ON INFO-COUPON PAGE 64



Call on Mr. Electrode

See Maurath, Inc. For

Stainless and Heat Resistant ARC WELDING ELECTRODES

• • •

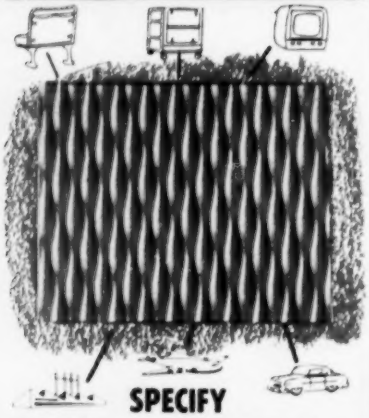
AUTOMATIC WELDING
All Analyses - Coated, Straightened - Cut - Coiled and Spooled



MAURATH, Inc.
21830 MILES AVENUE
NORTH RANDALL 22, OHIO
Phone: MOntrose 2-6100

LIST NO. 72 ON INFO-COUPON PAGE 64

STRENGTHEN BEAUTIFY PROTECT your product



SPECIFY

RIGID-tex METALS

Take that new product of yours, make it dent-scuff-scratch-resistant, give it plenty of rugged impact resistance, reduce its weight and double its strength, and finish it up by packing it full of buying-eye appeal. You can do *all* this when you specify Rigid-Tex Metals right into your product designs! Find out for yourself.

Send for new 16-page complete catalog—on company letterhead, please—or see Sweets Catalog 1a/Ri.

RIGIDIZED METALS

RIGID-TEX METALS CORPORATION

50 Warehouses & Sales Representatives in All Principal Cities

LIST NO. 64 ON INFO-COUPON BELOW

USE OUR

HOEGANAES SPONGE IRON POWDER

for

Powder Metallurgy Fabrication and other Metallurgical Purposes

EKSTRAND & THOLAND, Inc.

441 Lexington Avenue
New York 17, N. Y.

LIST NO. 63 ON INFO-COUPON BELOW

"SILVERCOTE"®

BERYLLIUM COPPER

TITANIUM • BRONZES • ALUMINUM
COPPERWELD • SILVER PLATED WIRES
OTHER NON-FERROUS

ROUND **WIRE** FLAT

for

* SPRINGS
* FORMS
* ELECTRONICS
* SPECIAL PURPOSES

LITTLE FALLS ALLOYS

INCORPORATED
189 Caldwell Ave. • Paterson 1, N. J.

LIST NO. 66 ON INFO-COUPON BELOW

WHITELIGHT

MAGNESIUM

your comprehensive independent source of magnesium alloy
Tubes • Rods • Shapes • Bars
Hollow Extrusions • Plate • Sheet
• Pipe • Wire • Welded and Riveted structures and assemblies

WHITELIGHT MAGNESIUM

WHITE METAL ROLLING & STAMPING CORP.

82 Moultrie St., Brooklyn 22, N. Y.

Sales Office
376 Lafayette St., New York 3, N. Y.

LIST NO. 67 ON INFO-COUPON BELOW

The Metals Handbook



1332 Large pages
1752 Illustrations
1057 Tables
803 Articles
1,620,000 Words
40,000 Copies in use

Here is a book without a competitor . . . . a book written by more than 500 scientists and engineers for all those who need accurate and authoritative information about metals. The Metals Handbook has been 25 years in the making. The current, 7th edition was compiled and written by 68 committees of the American Society for Metals; more than 500 contributors were handpicked by the Society as the top experts, the men best qualified to write the most authoritative possible reference book on metals, metal properties, fabrication and uses. The book is divided into 37 principal sections and contains 803 separate articles and data sheets on metals, properties, uses, processing, testing, inspection, control and research. All metals, all processes, are included. The 64-page index and 4-page section on how to use the book make it easy to find what you want.

Over 40,000 copies of this edition are now in use by scientists and engineers of all kinds who need accurate information about metals. Order your copy of the 1948 edition today. Price is **$15.00.**

American Society for Metals, Room 678
7324 Euclid Ave., Cleveland 3, Ohio
Rush me a copy of Metals Handbook.
NAME
COMPANY
ADDRESS
CITY STATE
☐ $15.00 Enclosed ☐ Bill me.

READERS' INFO-COUPON SERVICE, METAL PROGRESS
7301 Euclid Avenue, Cleveland 3, Ohio

Please send further information, as checked at the right, on the advertisements in the Bulletin Board with numbers I have listed below—

(Bulletin Board Item Number)	(Please check) Send Catalog or Engineering Data	Send Price Info	Nearest Source of Supply
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐

Your Name _____ Title _____
Company _____
Street _____
City _____ Zone _____ State _____



combined

in this basic modern material:

— beauty

— economy

— strength

— practicality

Su Veneer®

CLAD METAL

MOULDINGS of SuVeneer Copper or Brass Clad Metal exemplify *beauty and utility* in every application . . . mirror-bright, or satin-finished for rich color, as in the table-top sections pictured here. ● You benefit by lower cost, higher strength, standard ease of fabrication. *Write!*



Ask for your copy of our widely-read publication, "An Introduction to Clad Metals," free on request.

Superior Steel

CORPORATION

CARNEGIE, PENNSYLVANIA

Here's the most convenient way to make Refractory Concrete:

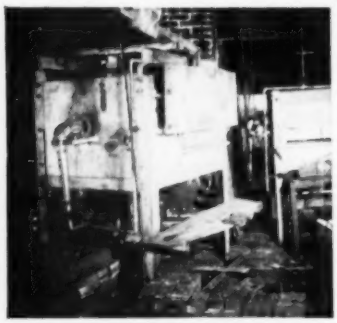




★ CAR TOPS
★ ARCHES ★ HEARTHS



★ SPECIAL SHAPES
★ CORE OVEN FLOORS



★ HEAT TREATING FURNACES
★ DOOR LININGS

IT'S THAT SIMPLE—Castable Refractories completely eliminate the need of finding suitable aggregates . . . and grading them to the right sizes. Packaged Castables come to you with Lumnite* calcium-aluminate cement and selected aggregates already mixed—needing only addition of water. The resulting Refractory Concrete reaches service strength in 24 hours or less.

This convenient way of making Refractory Concrete speeds work and cuts labor costs. It simplifies tough jobs—and some Castables are suitable for use at temperatures of 3000°F. or higher.

REFRACTORY CONCRETE made with Castables is the *adaptable* refractory. Easy to place in any size or shape.

No cutting or fitting necessary when you pour furnace walls, door linings and special shapes. There's no volume change to bother about. Build heat resistant floors, furnace walls, arches and hearths—Refractory Concrete withstands severe thermal shock, resists spalling.

In fact, you'll find Castables tailor-made for speed and convenience on many Refractory Concrete jobs. Handy for repairs, too.

CASTABLES to meet specific temperature and *insulation* requirements are made by manufacturers of refractories and sold by their distributors. For further information, write to LUMNITE DIVISION, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

*"*LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

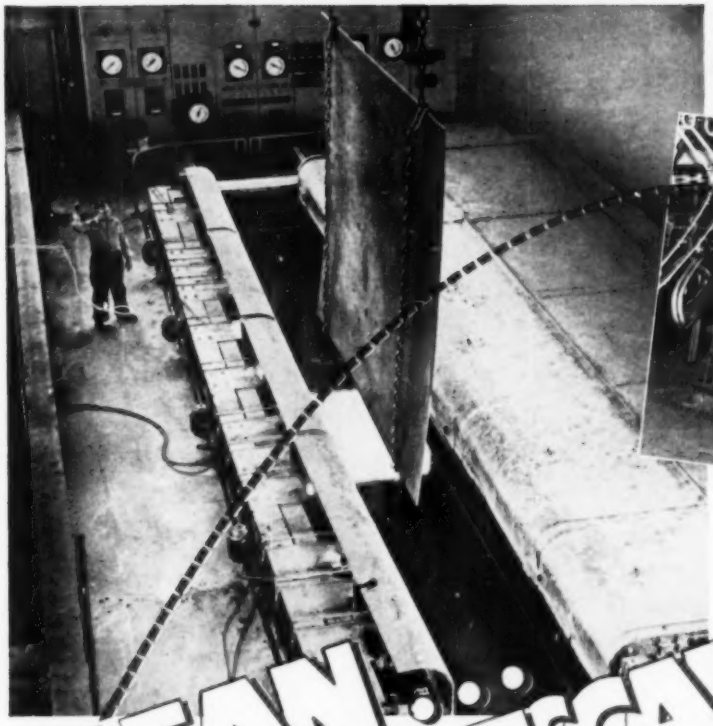
MP-L-54R

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

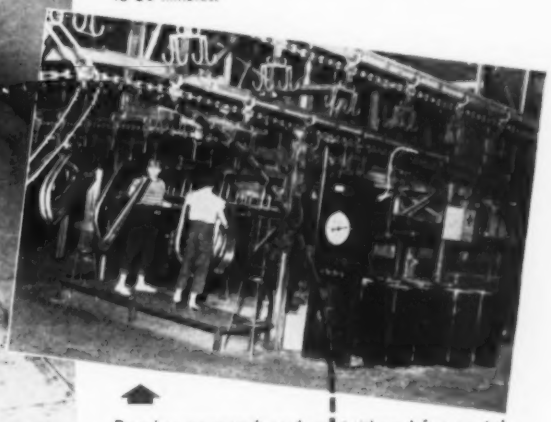
REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.



Stainless, carbon, alloy and high-speed tool steels and non-ferrous alloys descaled in from 15 seconds to 20 minutes.



Drawing compounds and paint stripped from metal stampings in 50 seconds.

CLEAN... DESCALE... DESAND

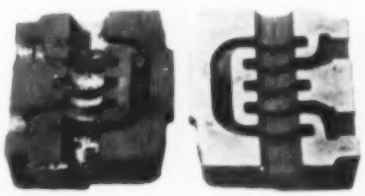
...faster, better at appreciably less cost

From removing metallic oxide scale from huge plates, coils or bars to desanding molds or cleaning residual materials from stampings, the Ajax Electric Salt Bath Furnace paves the way to appreciable savings in labor, floor space and time. What's more, the work is done far more efficiently than is possible with sand-blasting, acid pickling, electrolytic anodic cleaning or other methods.

The Ajax Salt Bath Furnace is adaptable to many metal and alloy types. Different metals and different metal shapes can be descaled simultaneously. The bath acts uniformly on all parts of the work including blind holes. The process reacts only on scale, sand or residual materials. The base metal is not affected and there is no hydrogen embrittlement. First cost of the equipment is low and so is upkeep. Pot and electrode life is measured in years and the bath can be regenerated indefinitely by the addition of low cost chemicals. Where desired, the entire process can be mechanized for highly efficient mass production.

Write today, giving details of your finishing problem. Let Ajax engineers prove these claims—at not the slightest obligation. Reprinted technical articles on cleaning, descaling and desanding are available on request.

Before After



Grease, drawing compounds, residual rubber, carbon black, plastics, paint and enamel removed in minutes with less labor.

Residual sand removed from these pump castings by 3-minute bath immersion at 700° F.

AJAX ELECTRIC COMPANY

WORLD'S LARGEST MANUFACTURER OF ELECTRIC HEAT TREATING FURNACES EXCLUSIVELY

910 Frankford Ave. Philadelphia 23, Pa.

Associate Companies: Ajax Electric Furnace Corp.; Ajax Engineering Corp.; Ajax Electrothermic Corp.



Trademark

AJAX ELECTRIC SALT BATH FURNACES

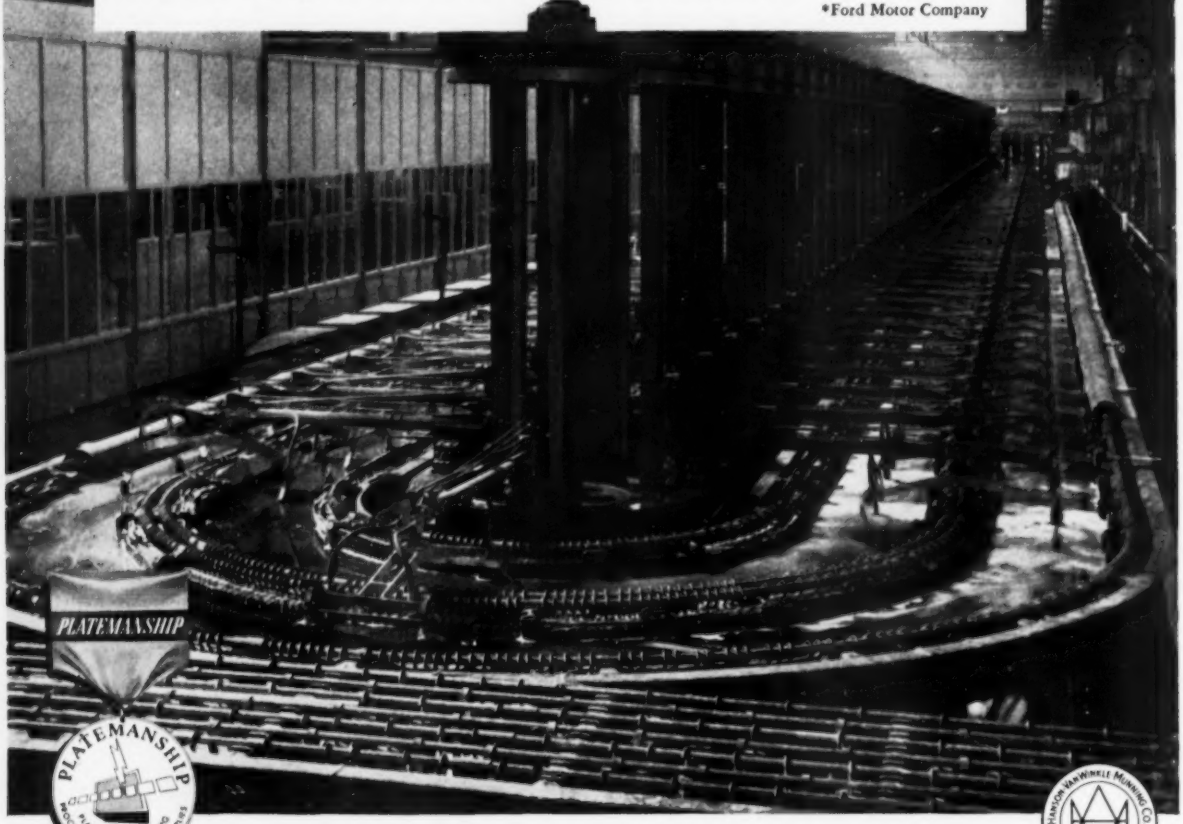


Yes, sir! that's the longest elevator type plating conveyor in the world...

When this customer* wanted a plating conveyor, he called in H-VW-M. You see, all H-VW-M conveyors are custom-engineered to fit the installation—every one is designed to solve a given production problem—no matter how large or small. They're built to handle a wide range of weight, current loads and lifts. Special features? Whatever the job requires. For example: delayed set-down for varying immersion time, treatment by-pass mechanisms, agitation—rack, air and solution, individual electrical control for each rack, and many others. This flexibility of design makes H-VW-M conveyors adaptable for practically any treatment cycle. They are now in operation for all types of plating as well as anodizing, pickling, cleaning, phosphate coatings, bright dipping, painting, etching, etc.

Full-automatic conveyors are but one of the many results of over eighty years of constant electroplating development . . . a continuous policy summed up in H-VW-M's Platemanship—your working guarantee of the best that industry has to offer, not only in plating conveyors, but in every phase of plating and polishing.

*Ford Motor Company



Write for Bulletin FA-103 for complete information on H-VW-M Full Automatic Conveyors.

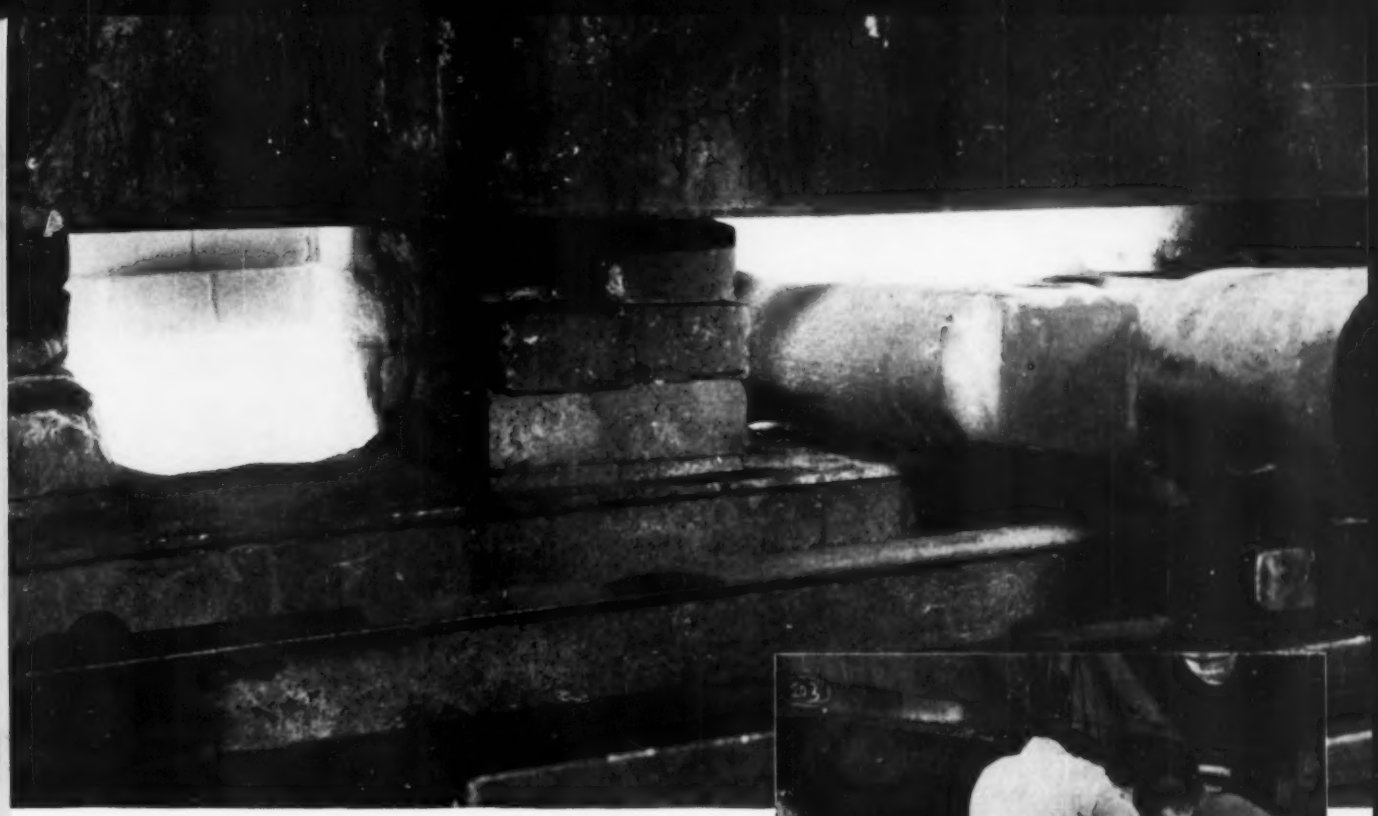
Your H-VW-M combination—of the most modern testing and development laboratory—of over 80 years experience in every phase of plating and polishing—of a complete equipment, process and supply line for every need.

HANSON-VAN WINKLE-MUNNING CO., MATAWAN, N. J.

PLANTS AT: MATAWAN, N. J. • ANDERSON, INDIANA
OFFICES IN: ANDERSON • BALTIMORE • BOSTON • CHICAGO CLEVELAND • DAYTON • DETROIT • GRAND RAPIDS LOS ANGELES • LOUISVILLE • MATAWAN • MILWAUKEE NEW YORK • PHILADELPHIA • PITTSBURGH • ROCHESTER SAN FRANCISCO • SPRINGFIELD (MASS.) • STRATFORD (CONN.) ST. LOUIS • UTICA • WALLINGFORD (CONN.)

H-VW-M

INDUSTRY'S WORKSHOP FOR THE FINEST IN PLATING AND POLISHING PROCESSES • EQUIPMENT • SUPPLIES





IF REFRACTORY "A" OUTLASTS "B" 4 TO 1

How Do You Figure Their Relative Costs?

The operator of this forge furnace solved a similar problem approximately as follows: He figured the cost of down-time for a furnace rebuilding job . . . plus labor costs . . . and added the price of the refractories. Then by multiplying the total cost of the short-lived material "B" by four, he had a direct comparison. Result: he shifted from standard firebrick to a super refractory.

The "A" material that lasts four times as long, is CARBOFRAX® silicon carbide refractory. It's used in the sidewalls, backwall and main arch of this furnace. When pictured, these refractories had already been in service 10 months, 12-13 hrs/day, 6 days/week. And they were still good for many weeks more. In contrast, when clay was used it lasted less than three months — and, of course, the furnace often needed rebuilding when in greatest demand.

Figure the difference. It has meant savings here. It can mean savings to you. The greater abrasion resistance, heat shock resistance, and other durable properties of CARBOFRAX brick add up to a refractory that *wears, and wears, and wears.* As a starter, send for "Super Refractories in Heat Treatment Furnaces." No obligation, of course.

THIS IS AN OIL-FIRED FURNACE used for sharpening drill bits. The dull bits go into the right hand opening and are heated for 30-40 minutes at 2000-2100 F. Then they are dressed, and returned to the left hand opening for tempering — about 30 minutes at 1450 F. The bits run 6"-8" in diameter, up to 5' in length, and weigh about 450 lbs each.



CARBORUNDUM
Registered Trademark

Dept. C-74, Refractories Division
The Carborundum Co., Perth Amboy, N. J.
Please send free booklet to:

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

DO YOU HAVE *tough*

X-RAY INSPECTION JOBS?

At the American Steel Foundries' plant in Newark, New Jersey, heavy steel castings are easily X-rayed due to equipment *flexibility.*

1 – *Constant Potential* high voltage generator produces more X-rays per KV than any other X-ray generator and does it over the range of 30-250 KV.
RESULTS – Materials from less than $\frac{1}{8}$" aluminum to 4" of steel can be radiographed in less time.

2 – Jib crane tubestand carries the X-ray tubehead 6' vertically above a minimum 33" target-floor distance and 10' horizontally while moving approximately 270° around the vertical column. Additional beam angulation and tube positioning features are built into tubehead mount. A small hoist may be added to aid in positioning the part.
RESULTS – Time kept to a minimum for positioning the tubehead over the parts despite their size or position.

With Westinghouse you have the assurance of a coast-to-coast staff that provides the best technical service and advice. Call your Westinghouse representative, or write to Westinghouse Electric Corporation, 2519 Wilkens Avenue, Baltimore 3, Maryland.



Westinghouse 250 KV Jib Crane Unit

X-RAY DIVISION • WESTINGHOUSE ELECTRIC CORPORATION • BALTIMORE 3, MARYLAND

FLUOREX
PORTABLE UNITS
X-ACTRON
JIB CRANE
PRODUCTOGRAPH
MOBILE UNITS
GRAIN INSPECTION UNIT
SERVICE
ACCESSORIES

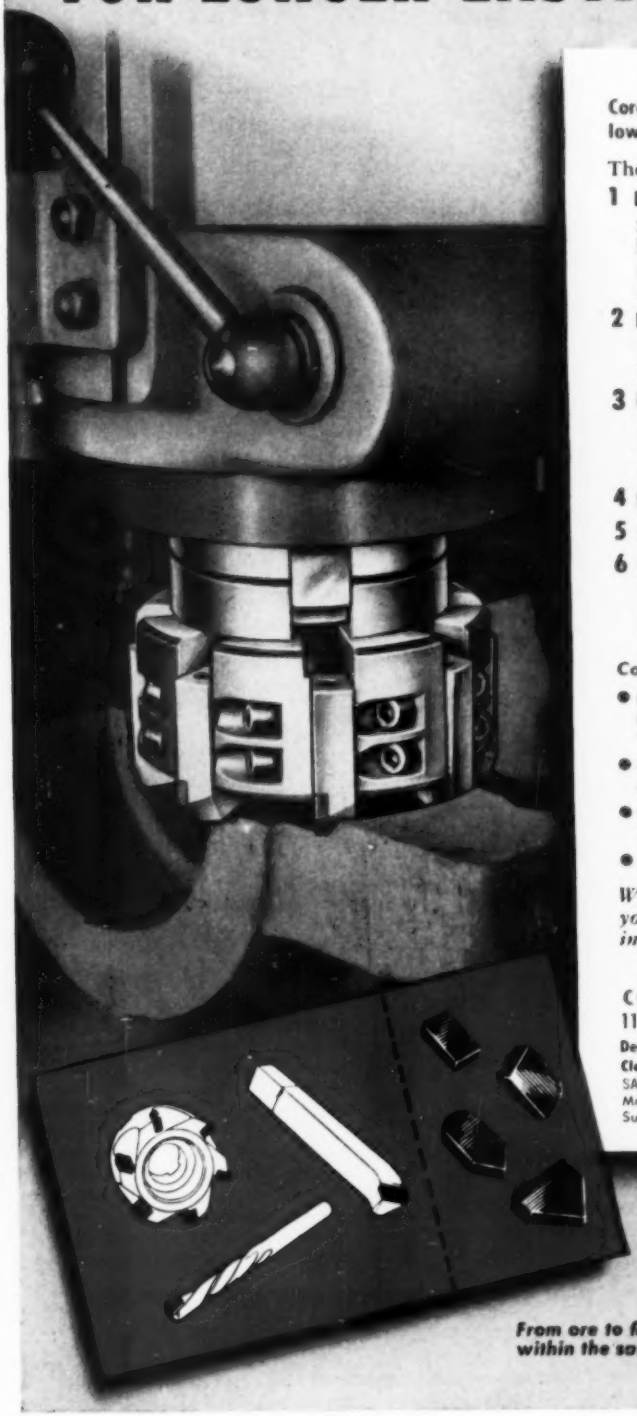
YOU CAN BE SURE...IF IT'S

Westinghouse

1-08268B

Try SANDVIK *Coromant*

CARBIDE TOOLS DESIGNED FOR LONGER-LASTING TOOL "BITE"



Coromant's quality and high wear-resistance means lower maintenance cost—higher production per tool.

The reasons for SANDVIK COROMANT's success are:

1 EXTENSIVE RESEARCH COMBINED WITH ENGINEERING SKILL

Sandvik's modern metallurgical laboratories have developed carbides extremely well suited in hardness, wear and cratering resistance and strength for every type of material.

2 BASIC PURITY OF RAW MATERIAL

The ore from Sandvik's tungsten mine is among the purest found anywhere in the world.

3 UNIFIED CONTROL BY SANDVIK FROM ORE TO FINISHED PRODUCT

From the tungsten mine through each production stage, Sandvik maintains close control and careful inspection.

4 HIGH QUALITY, SHOCK AND VIBRATION RESISTANT STEEL SHANKS

5 UNIQUE BRAZING METHOD WITH HIGH MELTING POINT BRAZING

6 COMPETENT ENGINEERING SERVICE

Thousands of work files are at your disposal along with well trained field engineers to help to solve your machining problems.

Coromant is available:

- **In a wide variety of tools and blanks from stock—including many shapes and designs which have been considered "specials" before.**
- **In all standard grades with improved performance to suit a wide range of applications.**
- **Grades permanently color-identified on the end of tool shank and etched in the carbide blanks.**
- **In the new, time saving "Coromant Combination Cutter."**

Why not try Coromant's long-lived "bite" on your application. Contact Sandvik for further information.

COROMANT DIVISION • SANDVIK STEEL, INC.
111 Eighth Avenue, New York 11, N. Y. • WAtkins 9-7180
Detroit: 20005 James Couzens Hwy, Detroit 35, Mich. • VE 7-9507
Cleveland: 1736 Columbus Rd., Cleveland 13, Ohio, CHerry 1-2303
SANDVIK CANADIAN LTD. • P. O. Drawer 430, Station O, Montreal 9, P.Q. • BYwater 7501 • 25 Milford Avenue, Substation 83, Toronto, Ontario • CHerry 1-3477

From ore to finished product within the same company

SANDVIK *Coromant*

55-98

UNICHROME

News about

COATINGS for METALS

Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New-Type Finishes Solve Metal Protection Problems

Unique groups of Unichrome Organic Coatings meet tough specifications—deliver unusual performance



United Chromium cooperates in working out answers to service and production requirements for metal finishes.

DIFFICULT problems of protecting various metals from corrosion with organic finishes can today be readily solved by means of new and unusual Unichrome Coatings. The finishes include plastisol coatings; eye-appealing coatings which are also in the highly corrosion resistant class; primers.

PLASTISOL USAGE PAYS

Unichrome Vinyl Plastisols are liquids or pastes with 100% solids. Cured at 350°F, they develop coatings with the best features of inert plastics and rubber. They deliver the unique combination of wide chemical resistance, resiliency, thick build-up on the part, and seam-free, pore-free protection.

Various types available now include practical *sprayable* compounds which deliver films up to 25 mils thick in a *single* sag-free coat.

These coatings are establishing remarkable service records. They often permit use of ordinary metals in place of costly alloys. For example: Half-ton stainless steel strainer bodies were replaced by plastisol-coated cast iron because of the remarkable chemical protection afforded by the finish. Applied to bleach reduction chambers, the Unichrome Plastisol Coating gave four times longer service than special alloy metal before needing maintenance.

MORE DURABLE FINISH

To simulate gold parts for refrigerator trim, one company used polished stainless steel and a Unichrome Transparent Tinted Enamel—which passed the 500 hour heat and humidity test and was still going strong 11,850 hours later. Tinted coatings with such durability can be used for other metals, too, for a finish that looks better longer.

PRIMER FOR LIGHT METALS

Wider use of magnesium and aluminum can now be made because finishing them need no longer be a problem. Unichrome Primer AP-10 assures dependable adhesion of top coats to these active metals. Rigorous tests by large metal producers proved it, usage has confirmed it.

* * *

These coatings exemplify a few of the specialized coatings United Chromium has developed to deliver exceptional performance on metal products. Send in the details on your requirements.

HELPFUL HINTS

by "Mr. Cost Cutter"

The shape of a piece can greatly affect the uniformity of its plated finish—sometimes even determines whether it can be economically plated at all. It pays, therefore, to check with the finishing department to learn whether any newly designed part to be plated will create problems which could cause many rejects and high finishing costs. If such is the case, minor changes can often be made which will avoid the problems in the *design* stage.

More tolerant nickel bath = more output

A plant installed the Unichrome Bright Nickel process alongside a larger tank of another nickel solution. Both plated identical parts. Yet Unichrome Nickel turned out more work. It tolerated impurities so much better that it took less time for purification. Now it occupies both tanks. Ask for bulletin NI-1.

NEW IMPROVEMENTS IN COPPER PLATING

New addition agents for use with Unichrome Pyrophosphate Copper Plating Solution have eliminated buffing for many users, made it easier for others who prefer to buff copper rather than the base metal or subsequent deposits. This is due to still finer grain and smoother deposits assured by the agents—which makes this copper also ideal for stop-off work in nitriding and carburizing operations. Use of the agents has also increased plating speed—as much as 20% in some cases.

UNITED CHROMIUM, INCORPORATED
100 East 42nd Street, New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill. • Los Angeles 13, Calif.
In Canada:
United Chromium Limited, Toronto 1, Ont.

Perfect for nut forming

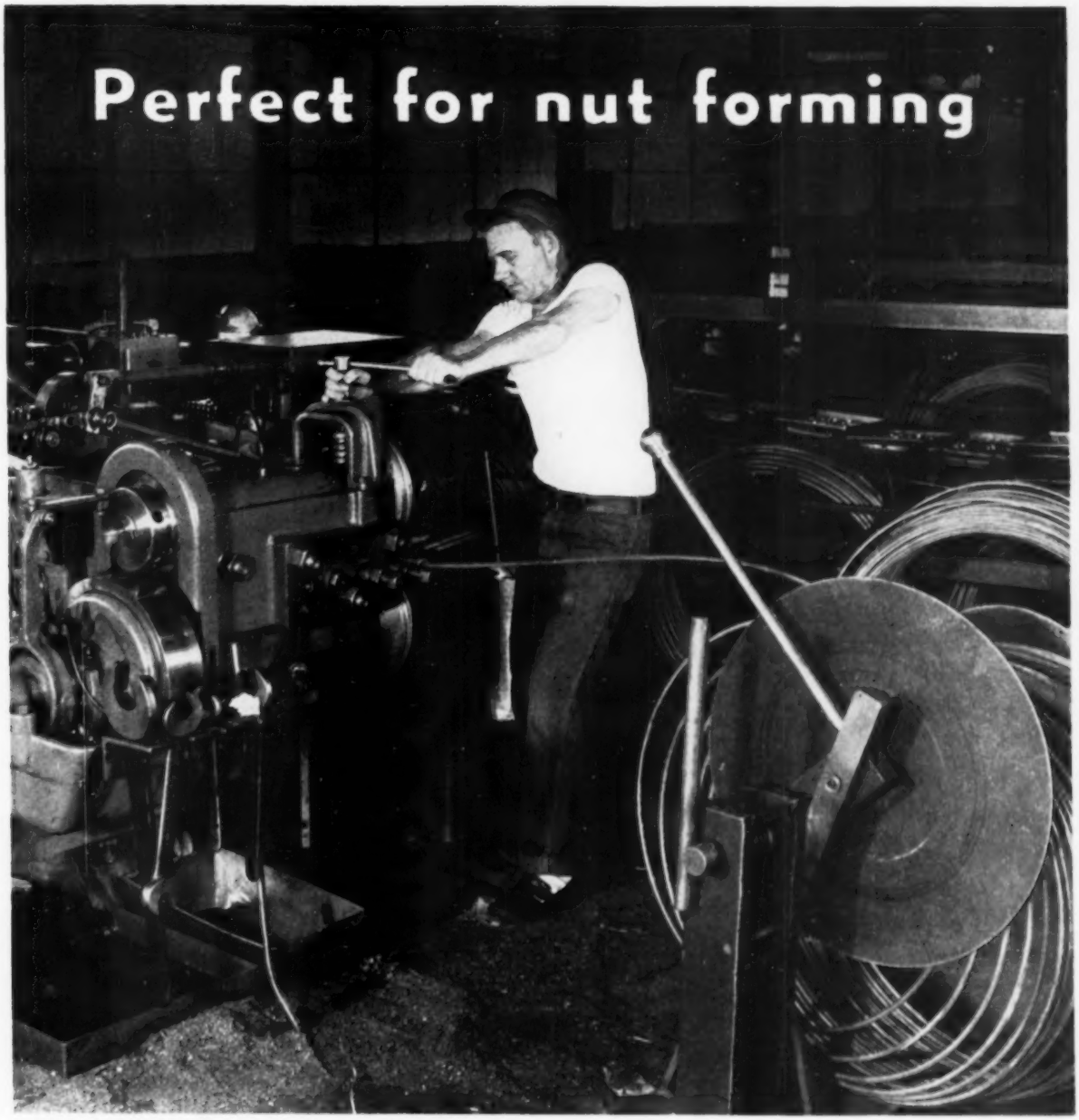


Photo courtesy of Decker Manufacturing Company

Youngstown

QUALITY YOUNGSTOWN SERVICE

SCRAPLESS NUT QUALITY WIRE

●Youngstown Scrapless Nut Quality Wire is outstanding for its excellent surface and sound internal structure. This uniform high quality results directly from close control of manufacture—from the ore mines clear through to finished product. Thus customers can always be sure that Youngstown wire will stand up under the punishing operations of cold heading, cold punching and thread tapping.

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices: Youngstown, Ohio - District Sales Offices in Principal Cities

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES



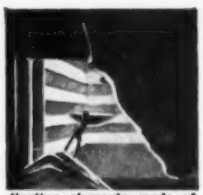
How Hot can a Jet Get?

Whoooosshh! Jet engines generate a powerful amount of heat . . . heat which, uncontrolled in flight, would cause disastrous metallurgical distortions within the delicately balanced engine. So the problem is . . . or rather *was* . . . how to provide a dependably accurate means of measuring exhaust temperatures so that the pilot might have control over how hot his jets get.

And the answer? Special wiring harnesses running from engine to instrument panel . . . harnesses now made exclusively with Hoskins Chromel-Alumel thermocouple alloys.

Yes, wherever durability and accuracy are required in a thermocouple . . . whether for jet engines or industrial furnaces . . . you'll find Chromel-Alumel *right* for the job. Extremely durable . . . highly resistant to heat, corrosion, oxidation . . . guaranteed to register true temperature-E.M.F. values within specified close limits.

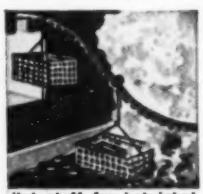
That's only part of Hoskins' product picture, though. Other specialized quality-controlled alloys developed and produced by Hoskins include: Alloy 785 for brazing belts; Alloy 717 for facing engine valves; special alloys for spark plug electrodes; Alloy 502 for heat resistant mechanical applications. And, of course, there's Hoskins CHROMEL . . . the *original* nickel-chromium resistance alloy used as heating elements and cold resistors in countless different products.



Heating elements made of Hoskins Chromel deliver full-rated power throughout their long and useful life.



Sparks fly better, last longer in today's spark plugs . . . thanks to Hoskins' spark plug electrode alloys.



Hot stuff for hot jobs! Hoskins Alloy 502 is ideally suited to many mechanical-structural applications.

Chromel® NICKEL CHROMIUM WIRE

HOSKINS

MANUFACTURING COMPANY

4445 LAWTON AVENUE, DETROIT 2, MICHIGAN



one stands out

...and REX is the standard by which all high speed steels are compared

It takes exceptional skill *and* experience to make consistent scores on the target range . . . or to produce consistently superior high speed steels.

Crucible has been making REX® High Speed Steels for over half a century . . . and REX is still the standard of comparison wherever high speed steels are used. That's no idle claim . . . and you can prove REX's superiority for yourself by putting a piece to work in your own shop. You'll like its hardenability, response to heat treatment, and good tool performance.

Once you've tried it, we think you'll agree — *you can't find a high speed steel that will outperform REX.*



CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **TOOL STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA · TOOL STEEL SALES · SYRACUSE, N. Y.

a **ton** of **clean** steel for a **dime**...



Approximately one pound of High Carbon Ferro Titanium added to a ton of semi-killed or killed steel can yield one ton of clean steel.

Titanium dioxide (TiO_2), formed from the addition, has excellent fluxing action with non-metallic inclusions such as silicates and aluminates. Low melting point oxides formed are carried up to the slag in the ladle.

Most effective scavenging action results when the amount of the alloy used is small—generally not more than 1 lb. per ton—and it is added in the ladle *after* such deoxidizers as aluminum, ferro silicon, etc.

Get complete facts by writing our New York City Office.

TAM
PRODUCTS
Registered U. S. Pat. Off.

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY

Executive and Sales Offices:
111 Broadway, New York City

General Offices, Works and Research Laboratories:
Niagara Falls, New York

PROCESS INSTRUMENTATION



General Electric Announces . . .

NEW RECORDING CONTROLLERS

Featuring Reduced Maintenance and the "Magnetic Standard"

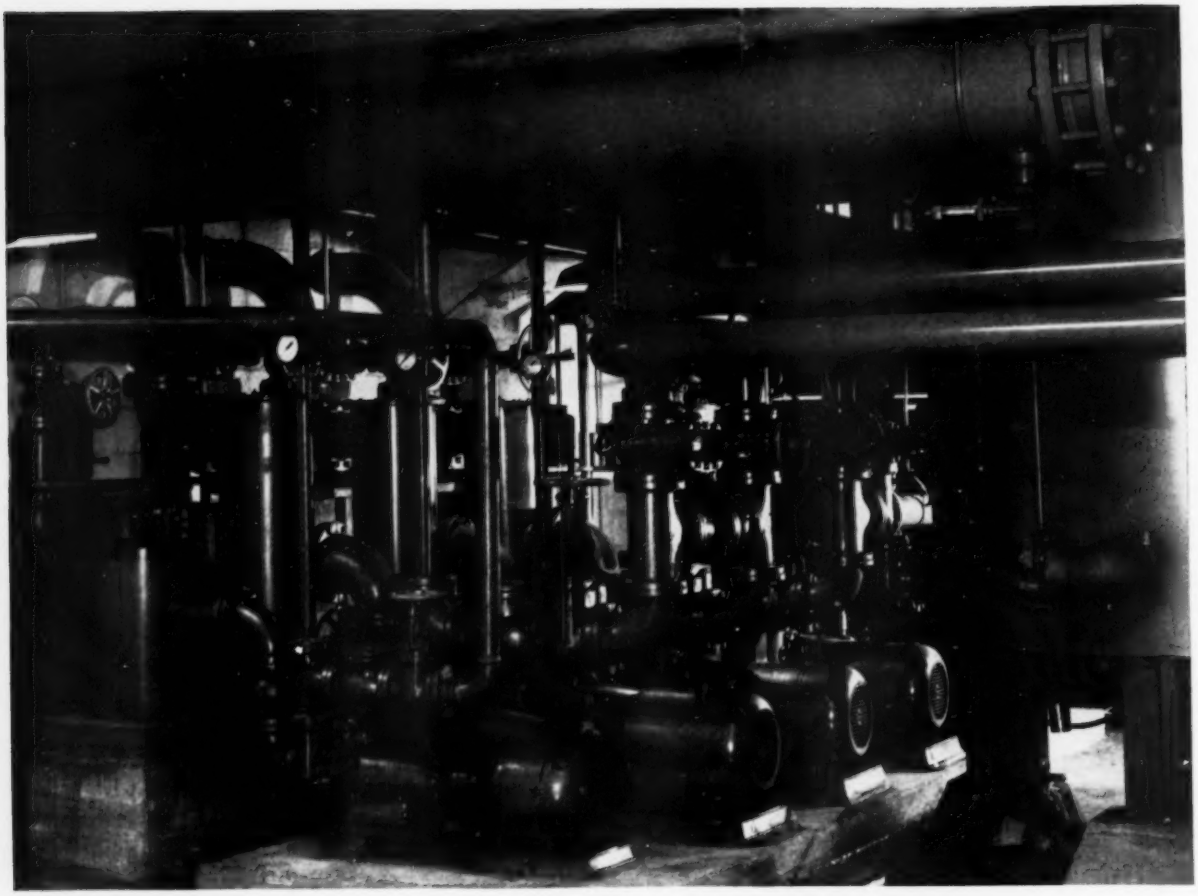
General Electric's newly designed recording controllers give you reduced maintenance through the "Magnetic Standard" in potentiometers and an improved bridge balancing unit in a-c bridge instruments. Eliminated are dry-cell batteries, standard cells and sliding contacts.

THE "MAGNETIC STANDARD" provides truly continuous standardization, as there is no lapse of control during standardization periods. This is especially important where a momentary loss of control has adverse effects on the quality of your product.

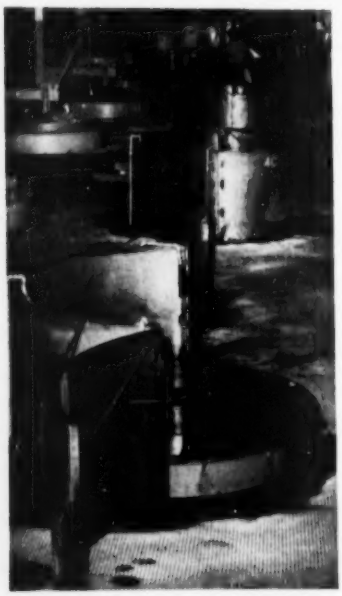
FOR FURTHER INFORMATION contact your nearest G-E Apparatus Sales Office or write for bulletin GED-2100, Section 602-284, General Electric Company, Schenectady 5, New York.

Progress is our most important product

GENERAL ELECTRIC



Controlled Quenching FOR BETTER PRODUCT



Battery of B & G Quench Tanks served by B & G Oil Cooling System illustrated above.

The above illustration typifies the quenching methods employed by modern metal fabricating plants to protect the quality of their products.

Here a battery of B & G *Hydro-Flo* Oil Coolers is employed to keep quench oil constantly at a predetermined temperature. By controlling quenching conditions, uniformity of product is assured.

B & G *Hydro-Flo* Self Contained Oil Coolers are complete packages... combining Coolers, Motors, Pumps, Strainers and all controls into single, integrated units. Fully automatic, they keep oil temperature at the desired degree through all stages of the quench.

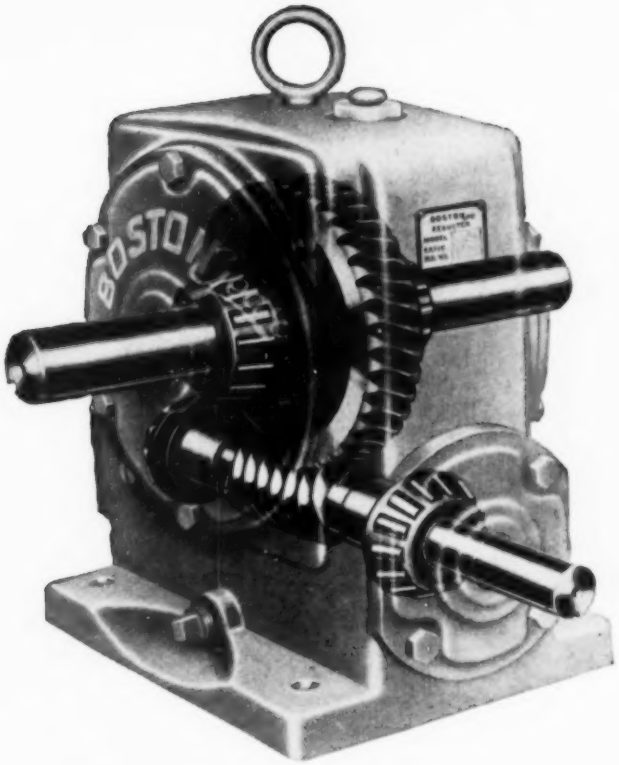
Or, if you prefer, the component parts of a B & G *Hydro-Flo* Oil Cooling System may be purchased and assembled on the job. B & G Quench Tanks are also available... either in standard designs or built to your specifications.

Send for Catalog and Simplified Selection Manual.

**Hydro-Flo*
OIL QUENCHING
SYSTEMS**

BELL & GOSSETT COMPANY
Dept. DM-16, Morton Grove, Ill.

*Reg. U. S. Pat. Off. *Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto*



How to make a worm gear stop spitting teeth

When a speed reducer transmits power to a machine, the output shaft takes a beating from the torque effect necessary to carry the load. If the steel can't take it, gear teeth wear excessively. Or they snap off.

Boston Gear Works had the problem with its Gear Reductor. Working with Republic's 3-D Metallurgical Service, they tortured gears and shafts made of many different steels.

Republic metallurgists recommended Cold Drawn 4140 Alloy Steel for the worm gear shaft for toughness and strength. For the worm and the worm shaft, which are integral, where hardness, machinability and smoothness were needed, 4615 Alloy Steel.

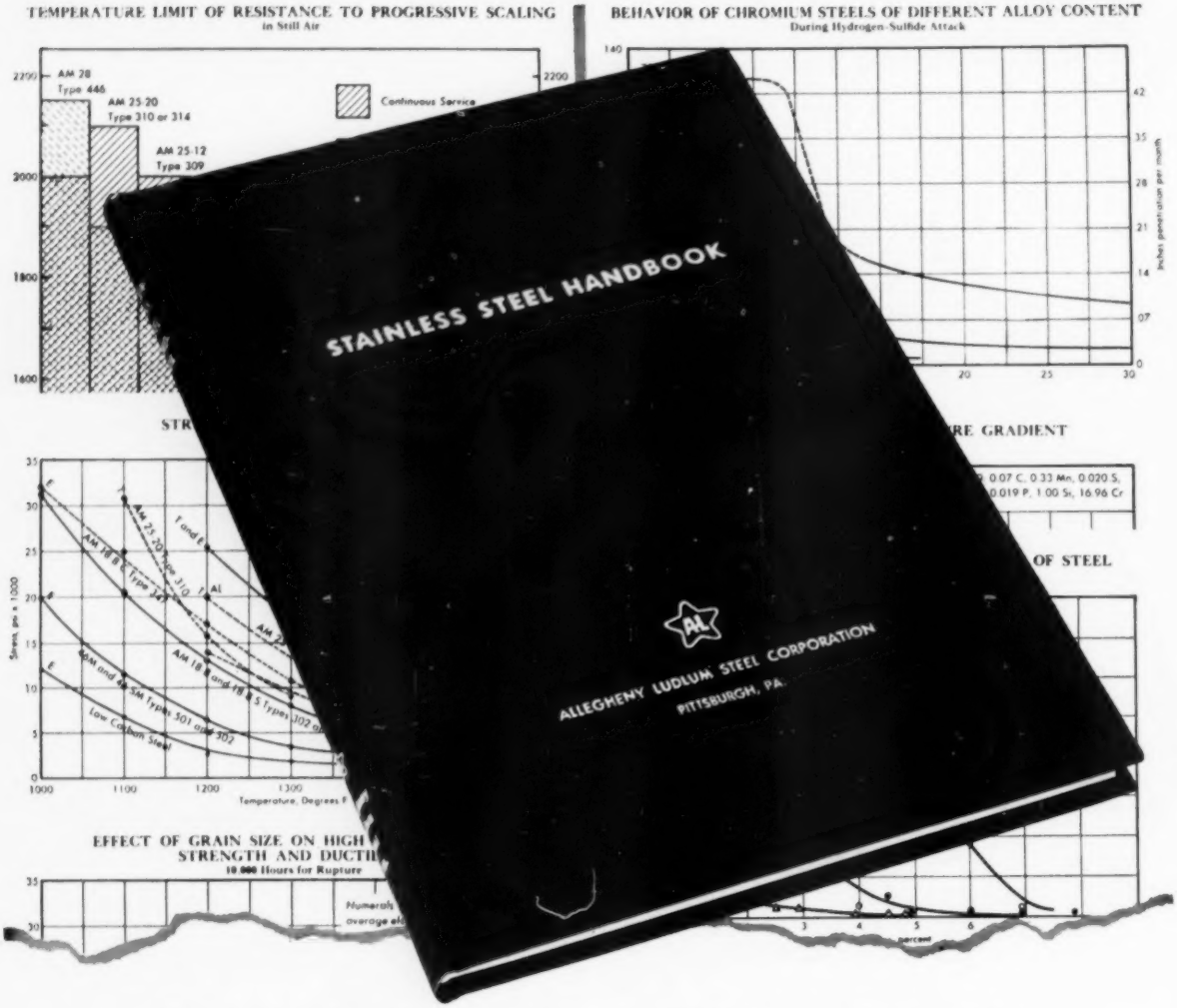
Result: A highly polished finish that assures proper meshing with the worm gear; a minimum of wear; a reductor that easily handles shock loads and 24-hour running conditions.

What about your problems? Perhaps the right alloy steels, recommended by Republic's 3-D Service, can mean better production rates. A better product. Or lower costs. Sometimes, all three. Phone your nearest Republic office for the facts. Or write to:

REPUBLIC STEEL CORPORATION
Alloy Steel Division · Massillon, Ohio
GENERAL OFFICES · CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC STEEL
REPUBLIC ALLOY STEELS

Other Republic Products include Carbon and Alloy Steels — Titanium — Pipe, Sheets, Strip, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing



Here's 124 Pages of Valuable Data on STAINLESS STEEL

Stainless and heat resistant steel can usually be classed as a critical material, since it not only contains strategic alloys but is indispensable in many vital industrial and armament applications. It is always important, therefore, to make every pound go as far as possible.

The latest edition of our comprehensive 124-page, case-bound Stainless Steel Handbook is ready for distribution now. It will help you to select the right stainless steel and to use it properly. Comprehensive listings of analysis, properties and characteristics of each type will guide you in specifying grades that will do your job most efficiently. Clear, concise fabrication data will help you speed production and cut waste.

Your copy of the Stainless Steel Handbook will be sent—*without charge*—upon request. Our only stipulation: please make your request upon your company letterhead. ● Write *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

ADDRESS DEPT. MP-55

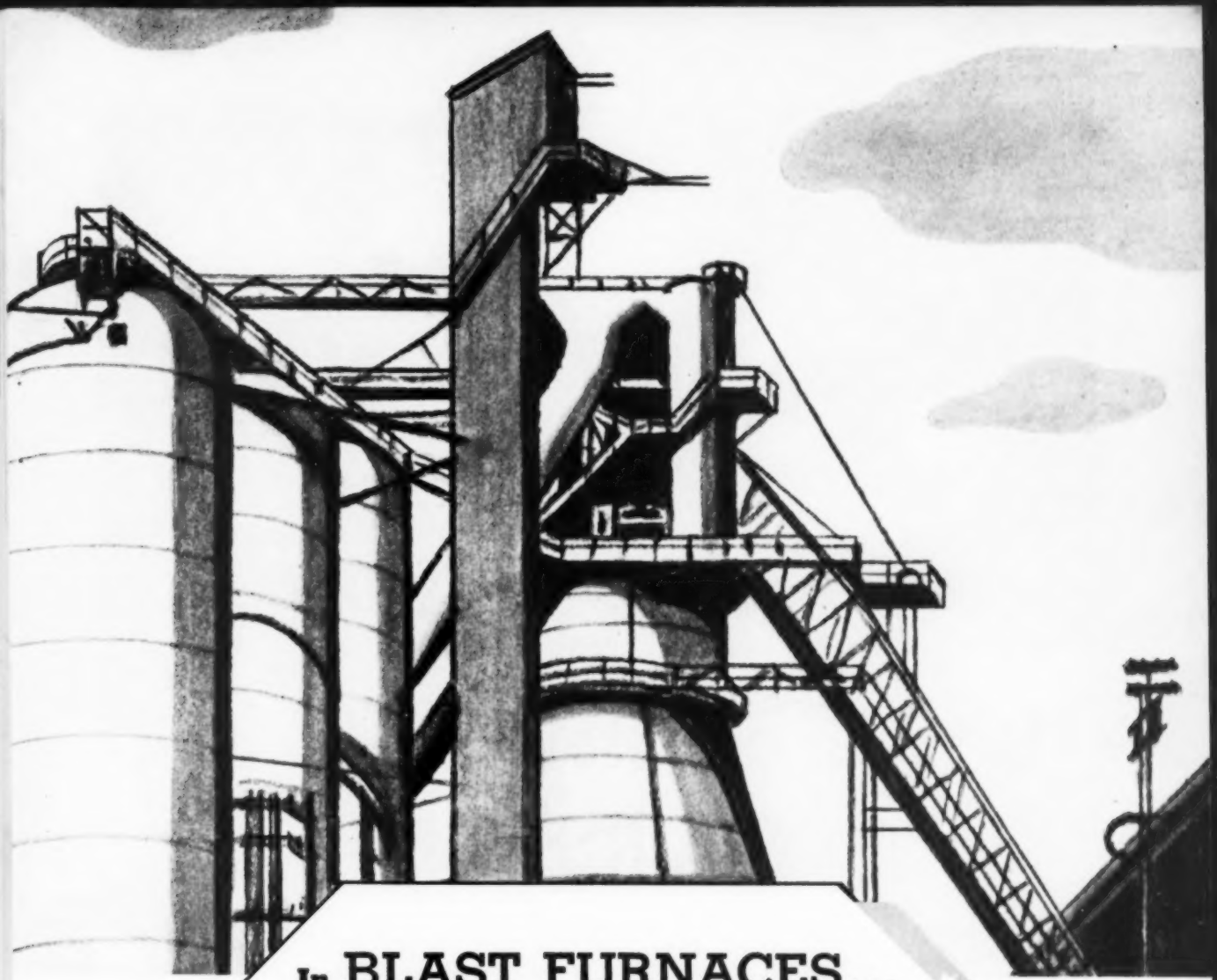
You can make it **BETTER** with

Allegheny Metal

AL® TIME-TESTED STAINLESS STEEL

WAD 5185

Warehouse stocks carried by all Ryerson Steel plants



In BLAST FURNACES...

GLC Carbon Brick helps accelerate production and reduce costs.

Important characteristics of **GLC Carbon Brick** are its strength and abrasion resistance at high temperatures, dimensional stability, low thermal expansion and thermal shock resistance. It resists slag build-up and is non-wetted by liquid metals.

The performance characteristics of **GLC Carbon Brick** are outstanding. May we tell you more about this exceptionally reliable product?

ELECTRODE DIVISION

Great Lakes Carbon Corporation

Niagara Falls, N.Y. GLC Morganton, N. C.

Graphite Electrodes, Anodes, Molds and Specialties

Sales office: Niagara Falls, N.Y. **Other offices:** New York, N.Y., Oak Park, Ill., Pittsburgh, Pa.

Sales Agents: J. B. Hayes, Birmingham, Ala.; George O'Hara, Long Beach, Cal.; Great Northern Carbon & Chemical Co., Ltd., Montreal, Canada.

Overseas Carbon & Coke Company, Inc., Geneva, Switzerland; Great Eastern Carbon & Chemical Co., Inc., Chiyoda-Ku, Tokyo, Japan.



Is there a better STAINLESS for you ?

2221 kinds, forms, finishes and sizes in our stock for quick shipment

So much improvement is being made every day in stainless. New extra-low carbon sheets and plates for special welding requirements, light plates for polishing and stainless tubing to name but a few. You may not be using the exact type that is best from a fabrication, long life or cost standpoint.

So we urge you to let our Ryerson stainless specialists help you select the right type for each particular purpose.

And whether you need stainless, or any other kind of steel, depend on Ryerson for immediate delivery from stock.

STAINLESS IN STOCK

SHAPES: Sheets & Strip • Plates • Rounds • Squares Flats • Hexagons • Angles • Pipe • Tubing Fittings & Fastenings

TYPES: 301, 302, 303-C, 303-S, 304, 304-L, 309, 310, 316, 321, 405, 410, 416, 430, 430-F, 440-C

CONDITIONS: Hot Rolled, Cold Drawn, Centerless Ground

FINISHES: #1, #2B, #2D, #3, #4

RYERSON STEEL

JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CHARLOTTE, N. C. • CINCINNATI • CLEVELAND DETROIT • PITTSBURGH • BUFFALO • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • SPOKANE • SEATTLE

Metal Progress
Volume 66, No. 1 July 1, 1954

Heavy Presses Near Completion

By ARTHUR H. ALLEN*

Large areas, thin sections and the complicated configurations of light metal forgings for aircraft call for press capacities far beyond anything yet constructed. It is hoped that new hydraulic closed-die forgings presses of 35,000 and 50,000 tons capacity will accomplish the task.

HEAVY presses for closed-die forging and extruding light metal alloys have been subjected to a barrage of publicity and controversy since initiation of the Air Force program a few years ago for construction and operation of some 17 large units at an estimated cost of $389 million. This project has waxed and waned, finally being cut back to ten presses on which work had progressed to the point where cancellation seemed impractical. Involved were horizontal extrusion presses ranging from 8000 to 20,000 tons rated capacity and vertical forging presses rated at 25,000, 35,000 and 50,000 tons (*Metal Progress*, March 1953, p. 111 and p. 186). As now constituted four of the new forging presses and six extrusion units will be in operation, probably some time this year.

Why the need for such large and costly presses? The best explanation is that progressive increases in size, weight, speed and range of modern aircraft – both transport and military – call for larger and stronger structural components in wings, fuselages and landing gears. If these elements can be shaped in single pieces, or at least in a very few pieces instead of the hundreds of small parts conventionally bolted or riveted together, added strength will result at lower cost.

The term "integrally stiffened structure" has been applied to such bulky sections in which the skin and skin-stiffening components are in one piece. It is further possible to distribute the material better and improve physical and mechanical properties by eliminating composite structures in favor of pressing out a single shape. Greater refinement of detail in both forgings and extrusions, thinner sections and closer tolerances, as well as reduced draft, will result from the increased pressures in the forming equipment.

However, limitations are placed on what can be accomplished, regardless of the size of the equipment or the pressures available. The news in the popular press that these large machines

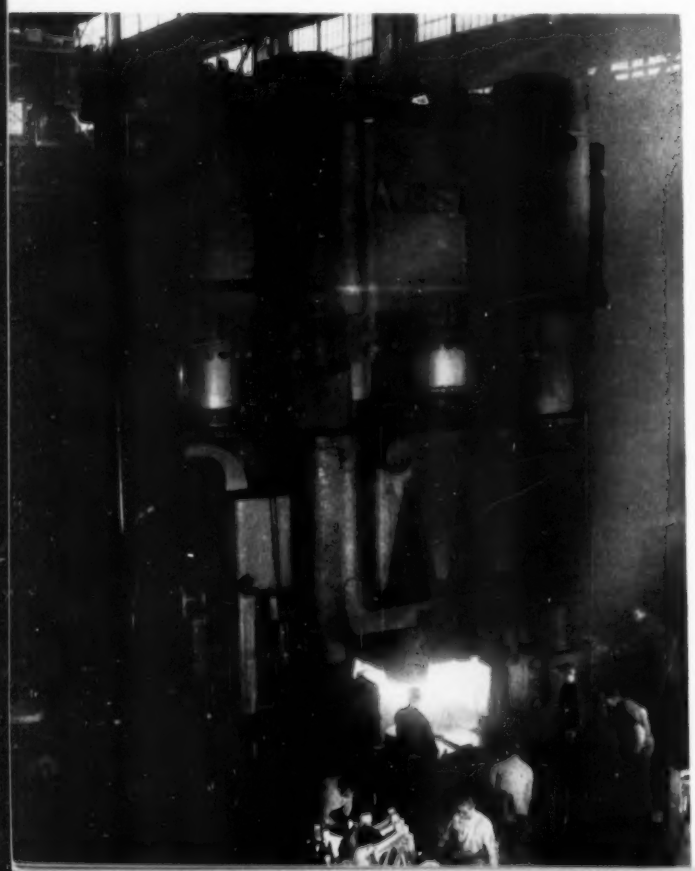
*Special Assignments Editor, *Metal Progress*.

would form an entire wing in one piece is completely outside the bounds of reason. A wing is a complicated built-up structure, housing hundreds of important elements. With these heavier presses, larger individual structural parts can be produced, thereby reducing the total number of individual pieces and, therefore, the number of joints in an assembly.

The above is a very simplified statement of the situation. Actually, there are many unexplored possibilities which can be developed only by close cooperation between aircraft contractors, designers, engineers, press builders and metal suppliers. Meanwhile it is pertinent to review some phases of progress in the design, construction and operation of heavy presses and the parts produced on them, in the effort to make a reasonable forecast of what the future holds.

The impression is widespread among engineers that knowledge about large and heavy press forgings of light alloys was nonexistent in the U.S. until intelligence teams immediately after the war discovered the Germans' activity. It is true that these experts did find that the Germans were operating large presses – two of 15,000 and one of 33,000 tons capacity – for producing large aircraft structural components; actually our own Air Force's interest in large forgings antedated this event by a few years.

Fig. 1 – This 18,000-Ton Forging Press Has Been in Operation for Nearly Eight Years at Wyman-Gordon Co. Stock is heated to about 850° F. before being placed in dies which are preheated to 750°. The four press pistons are 48 in. diameter, as are the four columns. Water under 5600 psi. pressure is the hydraulic medium



The American 18,000-Ton Press

As recalled by Robert W. Stoddard, executive vice-president of Wyman-Gordon Co., Worcester, Mass., the War Production Board asked his company to undertake special research in magnesium forging long before the end of World War II. Intensive studies were carried out and a voluminous report was dispatched. The result was a decision to build a hydraulic press larger than any previous one, for experimental work on magnesium and aluminum alloys. The expectation was that if the equipment proved satisfactory and there was a demand for the large parts which could be formed on it, additional facilities would be established.

After determining the design features of an 18,000-ton hydraulic press (in concert with Mesta Machine Co. and other firms interested in the program) Wyman-Gordon was requested to operate the plant in which it was to be erected at North Grafton, Mass. Because this was the only one of its kind in the country and because the experiments were likely to prove of benefit to the whole aircraft industry, the plant was carried through to completion following VE-day. Operations started in 1946. Since that time, the 18,000-ton Mesta press (Fig. 1) has been in almost continuous service. More than 125 designs of large forgings, principally of 14 S and 75 S aluminum alloys, have been produced to drawings by aircraft constructors – most of them in production lots. (In the aircraft sense, this means anywhere from 100 to 500 pieces, occasionally higher.) Parts ranged in weight from 50 to 600 lb. and included forgings for wing frames, ribs, spars, beams, wheel hubs and landing gears.

Output of this 18,000-ton press has been supplemented by that of the two 15,000-ton Schloemann presses operated by the Germans during the war, dismantled and shipped to the U.S. – at considerable cost and difficulty in transport, incidentally. One was erected at an Air Force plant now being run by Bridgeport Brass Co. at Adrian, Mich., the other at an Aluminum Co. of America plant in Cleveland. These units went into production in the summer of 1952. The still larger German press, rated at 33,000 tons, was commandeered by the Russians and nothing is known of its fate.

Principal specifications of the 18,000-ton press operated by Wyman-Gordon at North Grafton, Mass., will indicate its size and power:

Platen length	12 ft., 4 in.
Platen width	7 ft., 1 in.
Maximum opening between platens	10 ft., 6 in.
Length of stroke	5 ft.
Pressing speed	150 in. per min.
Columns and diameter	Four – 36 in.
Length of columns	46 ft.
Pistons and diameter	Four – 48 in.
Pushbacks and diameter	Two – 24 in.
Height of press above floor	32 ft.
Depth of press below floor	15 ft., 6 in.
Effective water pressure	5600 psi.
Volume of water in system	19,000 gal.
Power from three 1000-hp. pumps	3355 hp.
Weight of largest casting	348,000 lb.
Weight of press alone	2500 tons
Rated working pressure	18,000 tons

The success achieved with this press in the shaping of a variety of complex parts with integral ribs, flanges, bosses and reinforcements, under unit pressures up to 100,000 psi. and over an area of as much as 78x144 in., was a motivating factor behind the Air Force's decision to go on with its heavy press program. Wyman-Gordon was again asked to accept a leading part.

"Major" and "Minor"

A five-fold expansion of the North Grafton plant to a total floor area of better than 14 acres was drawn up, for installation of two huge new Loewy closed-die presses of 35,000 and 50,000 tons capacity, along with smaller units of 7700 and 1500 tons rating for pre-forming and trimming operations. The new buildings are now nearly complete and delivery of various components of this extraordinarily heavy machinery is well under way. It is expected that the 35,000-ton unit will be in operation late this summer and the larger one before the end of 1954. In all, the facility will represent an investment in excess of $50 million.

It is difficult to visualize the buildings necessary to accommodate these two presses. Wide, high bays, with 100-ton overhead cranes, must be provided to handle not only the erection and maintenance of the press itself but also the transfer of the enormous dies into and out of working position. Batteries of accumulator bottles, towering 35 ft. high, must be set up adjoining the press bay to supply the required hydraulic pressure. Extra-large mechanical manipulators, similar to openhearth charging machines, will handle the ingots and manipulate the forgings into and out the dies. The lower dies in the two new presses

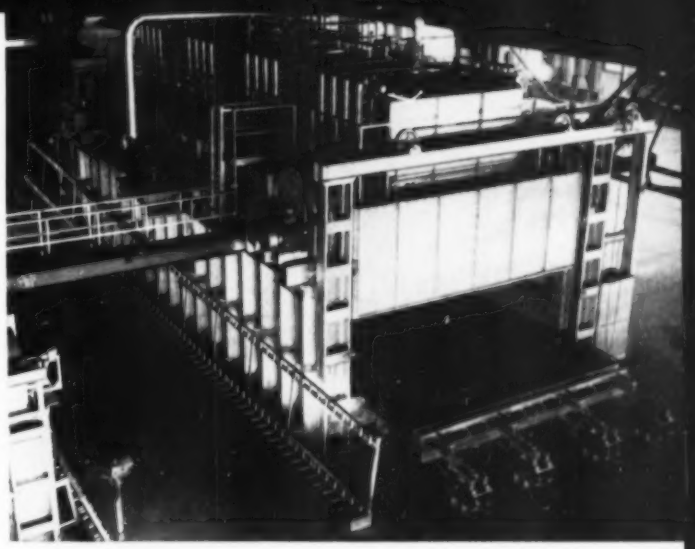


Fig. 2 – One of the Continuous, Indirect-Fired Furnaces for First Stage of Solution Heat Treatment of Finished Aluminum Forgings. Four combustion chambers are mounted on top of the furnace, with blowers to force heat into the furnace interior. Note unusually wide hearth

can be moved into accessible loading position by sliding lower platens.

Heating furnaces must be installed to preheat the dies before they are installed in the press. This is essential to avoid chilling the heated aluminum during the pressing operation and to aid the flow of metal into the die cavity. Additional buildings house furnaces for heating the ingots, and heat treating the finished aluminum forgings (Fig. 2), pickling equipment for removing graphite lubricant picked up by parts from the dies and for brightening the surface, and an extensive area for inspection of parts, both in process and before shipment – this phase being most meticulous. Space is also needed for tool and diemaking, centering around a group of large Keller machines, Hydrotels and boring mills for die sinking from wood or plaster patterns.

Auxiliary Plant – The auxiliary operations incident to the operation of only three heavy presses are beyond all conception, even to those familiar with general practices in the pressed metal industry. It is doubtless true that the entire project represents a move into a new and unexplored field, so it may be understandable that planners decided to be on the ample side, insofar as available space was concerned. Actually, as the perspective sketches of the two new forging presses (Fig. 3) suggest, the floor area they occupy is relatively small, most of their bulk being above and below the floor. For example, foundation pits are 75 ft. deep, with supporting reinforced concrete walls up to 13 ft. thick.

The two presses, identified by their builder as

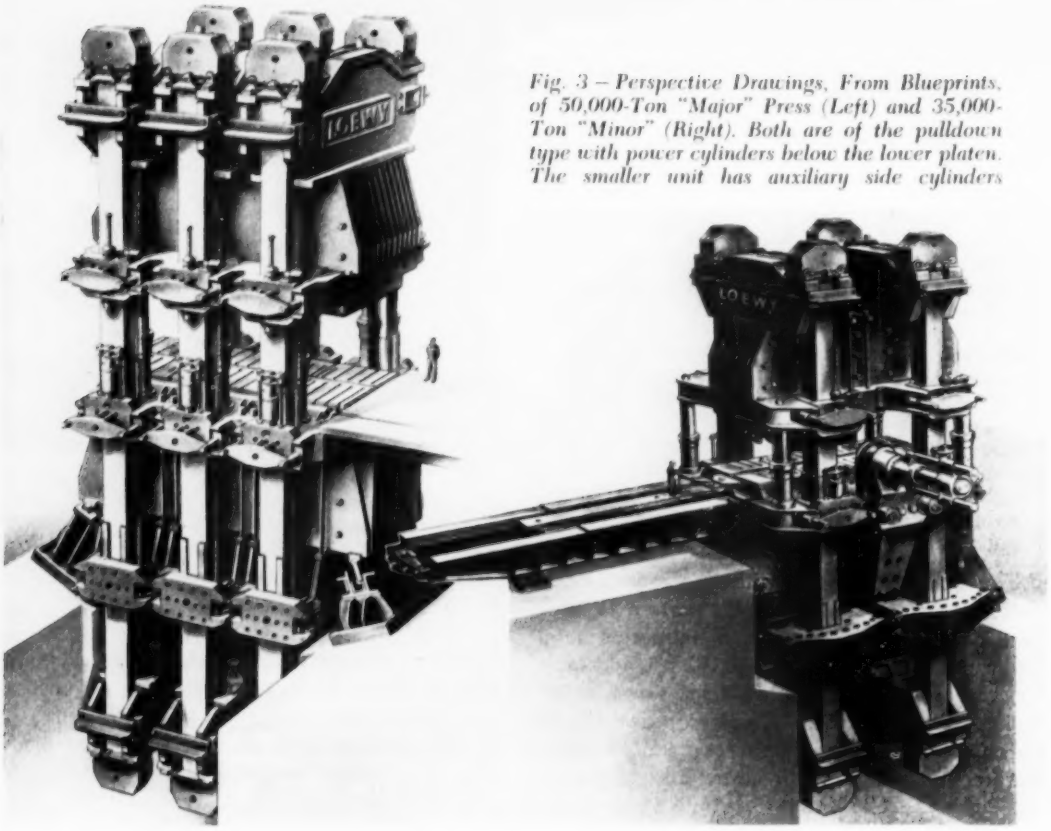


Fig. 3 – Perspective Drawings, From Blueprints, of 50,000-Ton "Major" Press (Left) and 35,000-Ton "Minor" (Right). Both are of the pulldown type with power cylinders below the lower platen. The smaller unit has auxiliary side cylinders

"Major" and "Minor", are of the so-called "pull-down type", all of the structure below the lower platens being below the working level. Hydraulic cylinders are placed below the lower press bed, and the upper head and platen are pulled down (rather than pushed down) against the metal in the dies. Principal statistics are as follows:

	35,000-Ton (Minor)	50,000-Ton (Major)
Number of columns	4	6
Length of columns	101 ft.	108 ft.
Height above floor	45 ft.	48 ft.
Depth below floor	62 ft.	66 ft.
Total weight	8550 tons	10,750 tons
Weight of moving parts	6000 tons	7500 tons
Die bed area	12 x 30½ ft.	12 x 32½ ft.
Maximum daylight	11 ft. 9 in.	13 ft. 9 in.
Minimum daylight	5 ft. 9 in.	7 ft. 9 in.
Stroke	6 ft.	6 ft.

Each press is equipped with main hydraulic power cylinders – six and nine, respectively – as well as return cylinders, eccentric load-compensating cylinders and pressure intensifiers. The smaller unit has auxiliary side cylinders permanently attached for exerting upsetting pressure in a horizontal direction if desired. Both have sliding tables holding the entire die bed.

A single accumulator station supplies hydraulic power for both presses. It includes 11 hydropneumatic accumulator bottles 63½ in. OD and 35½ ft. high, of forged steel 8 in. thick and weighing 85 tons each. Seven hydraulic pumps of 1500 hp. each provide a combined capacity of 10,500 hp. to force water into the accumulator bottles under a head of compressed air at 4500 psi. The hydraulic medium is water with a small admixture of soluble oil to prevent rusting. (Straight mineral oil is banned because of the hazard of a leak near the heated dies or work.)

Main structural members are composite. Transverse forged steel slabs, assembled and restrained by shrunk tierods, provide for rigid upper and lower platens, and minimize press-platen deflections. Tierods or columns are not of the conventional cylindrical type, but are rectangular in cross section and consist of three 8-in. thick laminations each. Since one column alone weighs close to 300 tons, it would have been impossible to make it in a single forging with existing equipment in the steel industry, so the arrangement of laminations was devised to expedite fabrication, machining and assembly. (See *Metal Progress*, June 1953, for a pictorial descrip-



Fig. 4 – Forging for Crosshead Support for the 35,000-Ton Press Is 47 Ft. Long, 14 Ft. High and Weighs 95 Tons. Welders at Bethlehem Steel Co. are attaching pads. The 22 bosses welded to each side of the support will receive 14-ft. bolts to hold together ten of the supports as a rigid backing for a set of forging dies

tion of the fabrication of these laminations.)

Hydraulic cylinders are so placed as to balance the hydraulic forces, reduce bending effects on the structural members and stress them in almost pure compression. Forces are transmitted through a gridwork of plate beams to the lower platen and through the main tierods to the upper head or entablature. In contrast to conventional presses, the entire upper entablature moves with the upper platen. One of ten plates to be assembled into the upper head is shown in Fig. 4. As many as six different pressure stages can be obtained by using various combinations of the hydraulic cylinders and by selecting either rated pressure of the accumulator system or by cutting in an intensifier arrangement.

To protect the press against excessive eccentric loads which might damage the main tierods or the press structure itself, a unique type of hydraulic force-compensation system has been perfected. Its action is entirely automatic and the degree of load compensation is a function of the rotational deflection of the upper entablature when it is subjected to an eccentric load resulting from the configuration of the part being shaped. The eccentric load-compensating system is designed to compensate for a compound eccentricity, coordinate to the center of the press platens.

In addition, an automatic strain-gage protective system is incorporated in the design, with strain gages mounted permanently on the tierods. When safe stretch in the columns is exceeded, the hydraulic system is unloaded automatically. These strain monitors are coupled to an electronic control which also watches the strain rate, so that for any dangerous combination of absolute strain and strain rate the power will be shut off.

Advantages of Press Forgings

Operating experience with the old 18,000-ton press has demonstrated significant advantages of hydraulic press forging of light metals over hammer forging. In the first place, die life is much longer. Furthermore, only slight draft angles – seldom over 3° – are required in the single-stroke operation, assuming suitable ejector devices, which means weight savings in parts. Closer dimensional tolerances can be maintained since dies are kept in alignment during the forging stroke by accurate guide pins. Predetermined die temperatures can be maintained on both the upper and lower dies, as previously described; this reduces mismatch and shrinkage.

Production rates can be increased on the hydraulic press, especially on larger and heavier forgings, because of the single-stroke feature, although naturally some shapes are given several press strokes.

Studies of press operating cycles, where a lower platen slide is used, show that the power stroke and return stroke require not more than 15% of the complete floor-to-floor cycle. Even without a table shift, the operating time of the press seldom exceeds 50% of the total time required. The rest of the cycle is consumed by handling material into and out of the press.

The hydraulic press lends itself to production of complicated forging shapes, such as those with sharp bends, internal bores and nonsymmetrical contour. Many of these would be impossible to handle by impact forging techniques.

While there is never much reason for complacency in any branch of the rapidly developing metals industry, Americans can take some comfort in knowing that big presses were making big forgings of aluminum as early as the vaunted Germans, and that the heavy-press program, started after the war, is in no sense of the word a boondoggle, but comprises a necessary group of plants for manufacturing the large, strong and light structures required for tomorrow's air transport and military aircraft.

Sigma Phase—a Review

*By ADOLPH J. LENA**

Its effects on the room and elevated-temperature properties of commercially important alloys.

THE INCREASED demand in recent years for alloys that can be used at elevated temperatures has been the motive for many investigations of the factors responsible for the formation of sigma phase and its effect on the properties of alloys. Significant achievements of these studies include: the establishment of the composition limits of sigma formation in a large number of alloy systems, including many of commercial importance such as the iron-chromium, iron-chromium-nickel and the iron-chromium-molybdenum systems; a better understanding of the influence of sigma on the properties of alloys at room and elevated temperatures; the derivation of the crystal structure of sigma and the formulation of a number of theories to account for the formation of sigma in binary systems.

The purpose of this article is to provide a survey of the effects of sigma on properties for specific applications, and to provide a general guide† to future research in this field. The article will be presented in three parts: The first pertains to the compositional limits of sigma formation in alloys of the stainless steel types; that is, basically iron-chromium and iron-chromium-nickel alloys; the second part will report on the effect of sigma on the mechanical, physical and corrosion properties of these alloys; the third part will consider the formation of sigma in other binary and ternary alloys, the crystal structure and the identification of sigma.

The first to observe the phase which we now designate as sigma were E. C. Bain and W. E. Griffiths in 1927; later this constituent was identified as the compound FeCr. Because of the extremely slow rate of transformation which is characteristic of the formation of sigma in annealed alloys of high purity, the numerous investigators who followed failed to detect sigma in alloys of a proper composition and there was considerable doubt until 1934 as to the actual existence of this new phase.

Sigma in Ferritic Fe-Cr Alloys

The best description of the formation of sigma in pure iron-chromium alloys with chromium contents from 25 to 76% is that given by A. J. Cook and F. W. Jones in the *Journal* of the Iron and Steel Institute, Vol. 148, 1943. Their phase diagram, Fig. 1, shows that the sigma region has a range of solid solubility extending from 44 to 50 atomic % chromium, and that sigma coexists with ferrite over an appreciable range of chromium content on either side of the single-phase region. They found it in 26% chromium alloys of high purity at 1110° F., and located the maximum temperature of its formation at 1508° F. for a 50% chomium alloy. This diagram is believed to be the most accurate published because alloys of great purity were used, and because equilibrium conditions were obtained by cold working the samples prior to aging. In respect to the effect of cold work, it was found that filings of a 53% chromium alloy reached equilibrium in two days at 1330° F., whereas samples of greater mass had not started to transform after 37 days.

Since commercial steels are not pure iron-chromium alloys, the effect of alloying elements on the compositional limits and rate of sigma formation must be considered. Thus, small amounts of silicon markedly accelerate the rate of formation of sigma. A thorough study of the iron-chromium-silicon system has disclosed that sigma is a stable phase over a large range of

*Associate Director of Research, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

†EDITOR'S NOTE—This paper is a review of the most significant investigations made to date of the formation of sigma and of its effect on the properties of alloys. To preserve its continuity, many of the credits and the complete bibliography submitted with the paper have been deleted.

compositions at temperatures as high as 1830° F. In addition to increasing both the rate and upper temperature limit, silicon expands the range of formation so that sigma can form in alloys of much lower chromium content than that found in pure iron-chromium alloys. Aluminum and molybdenum exert an effect on sigma formation that is similar to that of silicon, but the effect of aluminum on the rate of formation is not as great as that of either silicon or molybdenum. Small amounts of nickel and manganese expand the range of formation and increase the rate; however, when large amounts are present, austenite forms and these elements then exert a negative effect on sigma formation. The effect of nickel in amounts less than 4% is to make the alloys more susceptible, and in amounts greater than 4% to make them less susceptible to sigma formation. Manganese, according to one investigator, has a greater positive influence than nickel, even when present in large amounts. However, it should be remembered that much greater quantities of manganese than of nickel are needed to stabilize the austenite, and it is generally believed that manganese and nickel are similar in their behavior. This is substantiated by some unpublished work on austenitic iron-chromium-manganese alloys which will be mentioned later in this review.

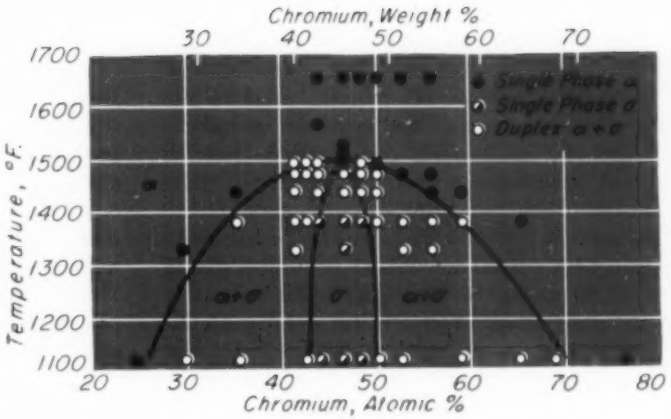
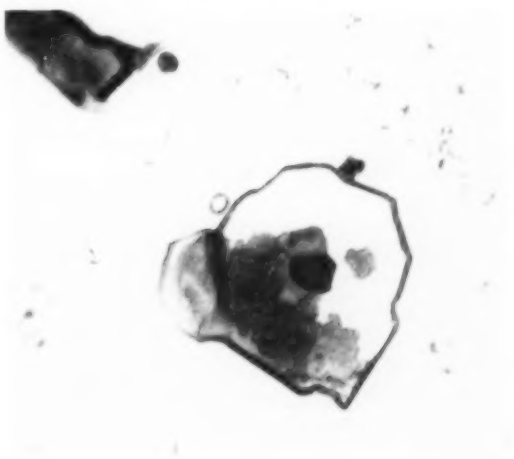


Fig. 1 — Iron-Chromium Phase Diagram Showing Limits of Sigma Phase Formation in Pure Alloys. (Derived by A. J. Cook and F. W. Jones)

Sigma has been found in iron-chromium-carbon alloys containing from 30 to 60% chromium and as much as 1.5% carbon after being annealed in the range of 1470 to 1740° F. The effect of carbon is to decrease sigma formation in iron-chromium alloys, this being attributed to the removal of chromium from solid solution by the formation of chromium carbide. Also, the presence of carbides decreases the threshold time for sigma formation in alloys where the effective chromium content (chromium in solution) is the same as that for carbide-free alloys. This apparent nucleation effect of carbide particles has been observed by a number of investigators who have found sigma in direct contact with carbide particles. An interesting example of this is shown in Fig. 2, which is a photomicrograph of a 31.6% chromium steel annealed at 2000° F. and then aged at 1200° F. for 900 hr. The dark etching phase in the center is chromium carbide, the gray is sigma and the white is austenite which had formed adjacent to the carbide at the annealing temperature. (M. A. Grossmann described this type of austenite formation in *Transactions* of the American Institute of Mining and Metallurgical Engineers, Vol. 75, 1927, p. 214.) In order to differentiate these phases, the alloy was first etched in boiling 50% HCl to outline them and then in boiling modified Murakami's solution to stain them. The sigma areas which photograph as gray were actually a series of bright opalescent colors under white light.

The effect of alloying elements on sigma formation in basic iron-chromium alloys can be

Fig. 2 — Photomicrograph Showing Apparent Nucleation Effect of a Carbide Particle on Austenite and Sigma Formation in a 31.6% Chromium Steel Annealed at 2000° F. and Aged for 900 Hr. at 1200° F. Etchant: boiling Murakami's solution (modified) superimposed on boiling 50% HCl. 2000×



summarized briefly by saying that elements which can be designated as ferrite stabilizers (silicon, molybdenum, aluminum, tungsten, vanadium, titanium and columbium) promote the formation of sigma; the austenite stabilizers (nickel and manganese) may either promote or retard it, depending upon the amount of these elements with respect to the austenite-to-ferrite balance. It is obvious from this that commercial steels with normal amounts of impurities should be more susceptible to sigma phase formation than pure alloys of equal chromium contents.

F. J. Shortsleeve and M. E. Nicholson (*Transactions*, ASM, Vol. 43, 1951, p. 142) investigated the extent of sigma formation in commercially pure alloys containing 15 to 35% chromium and derived a phase diagram of great practical importance, Fig. 3. It compares the boundary for ferrite: ferrite plus sigma for commercial alloys containing less than 0.1% carbon with a similar boundary for pure alloys. These investigators also studied the rate of transformation in the region of 1100 to 1500° F. and found that the time-temperature-transformation curve followed the familiar C-shaped behavior which is characteristic of nucleation and growth processes, and that the temperature of maximum rate increased with increasing chromium content.

Sigma in Austenitic Fe-Cr-Ni and Fe-Cr-Mn Alloys

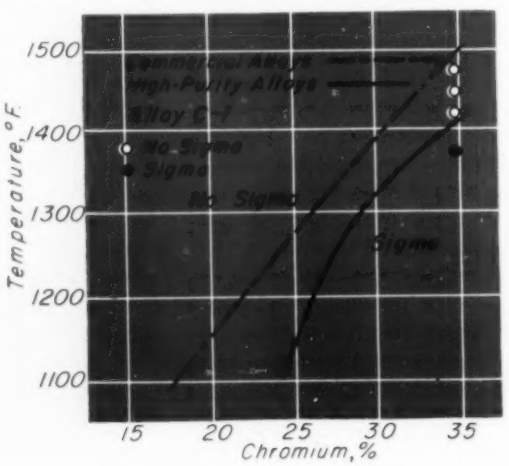
The formation of sigma in austenitic stainless steels has been the subject of intense study in recent years, principally because these alloys are used at temperatures where hot strength is required and the embrittling effect of sigma can be quite deterimental. Although a number of phase diagrams defining the limits of the sigma-phase regions in iron-chromium-nickel alloys of high purity have been reported, they are of little value in predicting the susceptibility to sigma formation of many commercial alloys having a composition that lies close to a phase boundary. In such alloys, variations in composition within the specified range and the presence of normal amounts of steelmaking elements may be sufficient to induce the formation of sigma, a condition which could not have been predicted from phase diagrams for pure alloys. These effects have been considered by M. E. Nicholson, C. H. Samans and F. J. Shortsleeve (*Transactions*, ASM, Vol. 44, 1952, p. 601) who presented a very useful diagram for alloys of commercial purity. Figure 4 from their paper compares their phase boundaries for commercial alloys (dashed lines) with those of higher purity (solid lines), and shows that at least a portion of the composition range of most of the A.I.S.I. austenitic stainless steels lies within the sigma-forming region. Quantitative data on the displacement of the phase boundaries due to the presence of silicon, manganese and molybdenum, have been provided by Nicholson and others. Similar work which includes alloys with 20 to 35% nickel has been reported by A. M. Talbot and D. E. Furman in *Transactions*, ASM, for 1953; they state also that cast structures resist sigma formation to a greater extent than wrought materials.

In regard to the formation of sigma in stable austenitic steels, there are some who believe that sigma forms from an unstable ferrite rather than directly from the austenite. This view was presented by early investigators and has been a source of confusion for some time in spite of the availability of sufficient evidence to discredit it.

Evidence of this direct transformation has been obtained by metallographic methods and by X-ray analysis. The latter method has revealed both the continuous transformation of sigma from austenite in stable alloys and the intermediate formation of ferrite in unstable alloys. As a result of this research, it is safe to assume that sigma forms directly from austenite but that the rate of transformation is usually very slow.

A large volume of information is available on the formation of sigma in commercial steels. The effect of molybdenum and columbium additions

Fig. 3 — Comparison of Phase Boundary for Commercial Alloys (With Less Than 0.1% Carbon) With the Boundary for Pure Alloys. Alloy C-1 was a 35% chromium high-purity alloy. (From the work of Shortsleeve and Nicholson, Transactions ASM, *Vol. 43, 1951)*



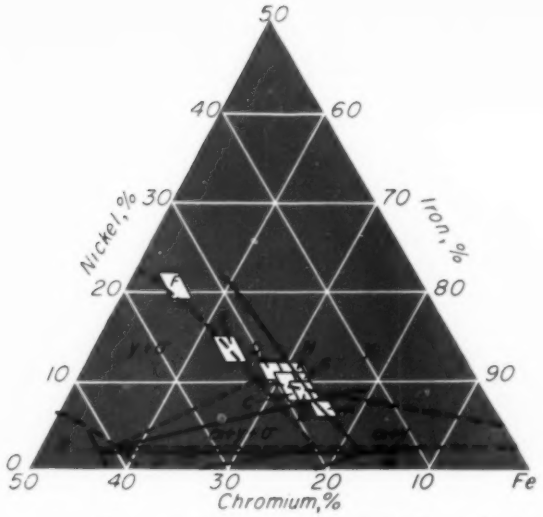


Fig. 4 – Relative Locations of Some Important A.I.S.I. Stainless Steel Compositions With Respect to the Limits of the Sigma Regions at 1200° F. Lettered regions indicate composition ranges of the following steels.

	Cr	Ni	A.I.S.I. Type
A	16-18	6-8	301
B	17-19	8-10	302,303
C	18-20	8-11	304
D	19-21	10-12	308
E	22-24	12-15	309
F	24-26	19-22	310
G	17-19	8-11	321
H	17-19	9-12	347

to 18% Cr, 8% Ni steels can be predicted from the diagrams by Franks, Binder and Bishop (*Transactions*, , Vol. 29, 1941) and thus one can balance the composition of this alloy to prevent the formation of sigma during stress-relieving. The prevention of sigma by proper composition adjustment enhanced hot workability of this alloy. These investigators found by making chemical analyses of extracted residues that sigma was richer in manganese, chromium, silicon and molybdenum and poorer in nickel than the original composition of the steel. Others have described the formation of sigma in Type 316 (18-8 Mo) which was initially entirely austenitic or contained some delta ferrite. The formation of ferrite as an intermediate stage in the transformation of sigma to austenite was observed during resolution of the sigma. The precipitation of carbides preceded the formation of sigma which was not complete in 3000 hr. at 1500° F.

Coarse grain and high initial annealing temperatures, up to 1560° F., retard the formation of sigma in Type 310 while cold working promotes it. Studies have been made and quantitative rate curves have been derived for sigma formation in annealed and cold worked Type 314 (25% Cr, 20% Ni, 2% Si) in the range of 1200 to 1800° F. Other commercial alloys in which its presence has been verified are Types 321 and 347. In Type 309 (25% Cr, 12% Ni), silicon is three times and molybdenum four times as effective as chromium in inducing the formation of sigma; columbium, titanium and aluminum are also influential in aiding its formation. Numerous investigators have written about the formation and effects of sigma phase in the heat resistant cast alloys.

Since sigma precipitates more rapidly in ferrite than in austenite, it should be expected that the presence of ferrite in austenitic steels would have a marked influence on the rate of sigma formation. Evidence of this has been reported for a duplex alloy of 18% Cr, 8% Ni, 3% Mo, and 1% Ti. Sigma in this alloy forms exclusively in the ferrite, and the partitioning of the alloying elements (which was verified by microradiographic studies) permits the remaining ferrite to transform to austenite. However, the reduction of alloying content of the austenite renders it unstable to the extent that the transformation to ferrite may occur on cooling. A reaction sequence is reported for an alloy of 19% Cr, 9% Ni with tungsten and molybdenum that involves the resolution of the carbide phase after sigma formation due to in-

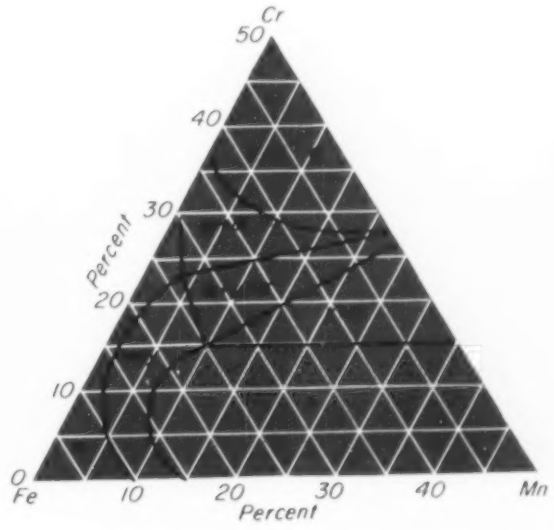
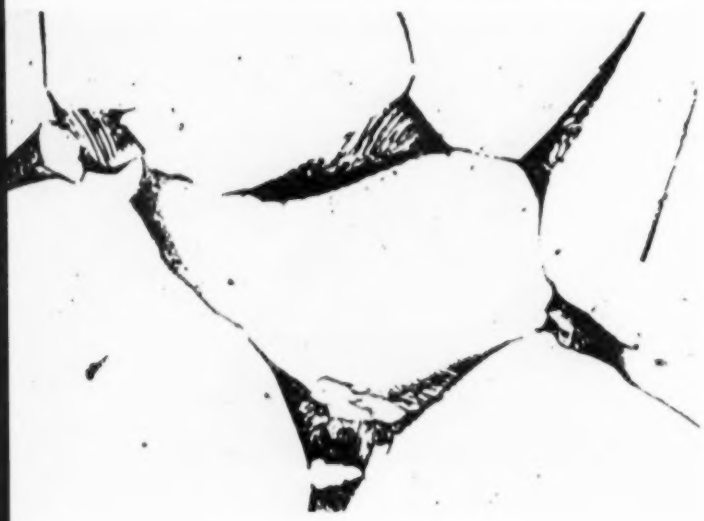


Fig. 5 – Isothermal Section of Iron-Chromium-Manganese Diagram at 1200° F. (According to C. O. Burgess and W. D. Forgeng, Transactions *of the American Institute of Mining and Metallurgical Engineers, Vol. 131, 1938, p. 277)*

creased solubility for carbon of the depleted austenite. During some recent work, the author observed that the carbide phase disappeared commensurate with sigma formation at 1475° F. in a Type 310 steel with 0.03% carbon, but was retained in a steel with 0.068% carbon. Apparently the solubility of carbon at 1475° F. in the austenite after sigma formation was greater than 0.03% but less than 0.068%.

Of present interest are the austenitic chromium-manganese stainless steels which have been developed as nickel-conserving replacements for the chromium-nickel varieties. Phase diagrams such as Fig. 5 show extensive regions of sigma formation in ternary iron-chromium-manganese alloys. However, there has been no information published on the susceptibility to sigma formation of the commercial steels of this type, and reference is made here to some work performed in the research laboratory of the Allegheny Ludlum Steel Corp. on a steel containing 15.12% Cr, 16.83% Mn, 1.0% Ni, 0.095% C, and 0.21% N_2. It had been anticipated on the basis of the previously mentioned data on the accelerating influence of manganese that sigma would form in this alloy at short times in spite of the low chromium content. However, no sigma was found in samples annealed at 2000° F. and aged for 1000 hr. at 1200 and 1400° F.

Fig. 6 – Micrograph of an Austenitic Chromium-Manganese Stainless Steel Showing Lamellar Structure Consisting of Chromium Carbide ($Cr_{23}C_6$) and Austenite Which Developed in Areas Which Were Originally Delta Ferrite as a Result of Aging for 4 Hr. at 1400° F. Etched with electrolytic 10% chromic acid. 1000×



In contrast to this, appreciable quantities of sigma can be produced in annealed Type 310 in as short a time as 250 hr. at 1400° F. These results substantiate the belief that the effect of manganese depends upon balance and that the presence of large quantities of manganese does not always insure rapid response to sigma formation. Cold work has a marked effect on promoting sigma formation in this chromium-manganese steel; a small amount of sigma was found in a 10% cold rolled sample after 1000 hr. at 1200° F., while a large amount was present in a 50% cold rolled sample after only 8 hr. at 1200° F. An interesting observation was made regarding the transformation of delta ferrite which had been produced by annealing at 2350° F. The delta ferrite in this alloy transforms rapidly at 1200 to 1400° F. to a lamellar structure consisting of chromium carbide and austenite (Fig. 6) with a complete loss of magnetism. Where this type of transformation occurs, there is no apparent accelerating effect of delta ferrite on sigma formation, since no sigma was found in these samples after 1000 hr. at 1200 to 1400° F. Since sigma is nonmagnetic, various investigators have made use of magnetic intensity measurements to study the rate of formation of sigma from delta ferrite. This method cannot be employed for chromium-manganese steels on account of the transformation of delta ferrite to carbide and austenite prior to the formation of any sigma. Because of the possibility of this transformation in other types of austenitic steels which contain delta ferrite, magnetic studies should always be correlated with metallographic or X-ray studies to verify the presence of sigma so as to avoid the possibility of erroneous conclusions.

Summary

The preceding review of sigma formation in ferritic and austenitic stainless steels shows that a large number of cast and wrought alloys are capable of developing sigma. Included among these are essentially all of the A.I.S.I. steels with chromium contents greater than 17%, as well as the newer austenitic chromium-manganese steels. However, it should be remembered that this is not always dangerous as far as use is concerned because considerable lengths of time are often required for the development of sigma in many of these alloys. This will be made more evident in a subsequent article which will describe the effects of sigma formation on the mechanical properties of stainless steels, which will constitute the second part of this review.



Light Metallurgy

Fatigue

By R. P. LISTER

EVERY space cadet, young or old, knows the super-jet Mullings Malignity Mark IV. It is one of the most familiar sights in our evening skies. With its four Thornibush Viper engines, housed in ninepin-shaped nacelles; its high aspect-ratio anhedral wings with bow-shaped leading edges and L-shaped trailing edges; its perfectly spherical tail fin and rudder set well forward on a triple-boom fuselage; its bubble cockpit unconventionally incorporated as an integral part of the undercarriage and its dodecahedral drop-tanks depending on thin duralumin wires from its astrodome, it swoops around the illimitable heavens like nothing so much as Captain Video in a state of acute delirium, making an unparalleled hullabaloo even when – and the occasions are rare – it refrains from penetrating the sound barrier. As for when it does so penetrate, the double boom produced by the bow-wave of each of the triple booms of its fuselage not unnaturally leads to a sextuple boom, the effect of which is normally to strip all the shingles and roofing-tiles off all the residential properties within earshot. Earshot is, in this instance, widespread; but, as the emergent householders philosophically remark to one another as they pay the repair bills, progress must go on.

Nobody would think, watching the Mullings Malignity Mark IV cavorting and caracoling about the empyrean with a business-like though earsplitting shriek, that such an indefatigable machine tended to suffer in any of its parts from anything so weakly human as Fatigue. Nevertheless, it does. In my old days as an aeronautical metallurgist fiddling about with prototype jettery, I was largely concerned with another peculiarity of metal known as Creep. On those occasions when I was not worrying myself about Creep I was worrying myself about Fatigue.

Fatigue is what happens to a metal – hot or cold, wet or dry – when it waggles. The quicker it waggles the sooner it happens. What happens is that it splits. That, baldly stated, is the essence of Fatigue. It is not the kind of thing one wishes to occur in the turbine blades of a Mullings Malignity Mark IV in which one chances to be riding in the evening skies. That it rarely does so is one of the minor miracles of science and major mercies of Providence. I do not claim to have played any great part in achieving this miracle – looking back on it now, I acknowledge frankly that I played none at all – but I was placed so I could see it all going on.

It was achieved by a number of learned bodies located in various nooks and crannies up and down the land. In these nooks and crannies, which were commonly though not universally situated underground, and always looked as if they were underground even when they were not, the learned investigators, whom I am happy to have claimed once as colleagues, strung up bits of metal in long rows like washing hung out to dry. These unhappy specimens they subjected to torture by waggling. Hot or cold, wet or dry – but usually hot and dry – they waggled them; and went on waggling them till, in the course of time, they split.

I, personally, never hung up a single bit of metal. I inhabited, in those high and far-off times, a fine great room commanding an incomparable view over the roofs of London. From

up there we could see, on a clear day, the Surrey downs. We could also observe the coal barges passing up and down the Thames, and use them as the basis for a kind of perpetual sweepstake, the details of which are too complicated to go into here – although the results, statistically speaking, were not wholly unlike the tidings the learned ones used to send me in that eyrie. This one, heated beyond endurance, had at last yielded; its brother, less ardent, still hung on. It was a cruel sport, but fascinating. We had no mercy on our miserable specimens. "Faster! Faster!" we would cry, like so many Red Queens. "Hotter! Hotter!" I would shriek from my distance, on prim official notepaper. From all over the land I seemed to hear the sharp, despairing crack of would-be turbine blades giving up the struggle. It was like some grim, ghastly battle of long ago; the whole kingdom seemed to me sometimes to be strewn with hewn and splintered fragments of metal.

After a few years of it I found the excitement too great, or else it was that the pay and prospects were unsatisfactory; at this distance of time I forget which. At all events, I quitted the field. The work was, in any case, largely done. Not that it is finished, of course; the battle goes on. In the slick labs the learned ones still eye their gages and command their minions to rewind the burned-out furnaces, or repair a machine outfatigued by its intended victims. But the initial struggle, the period of doubt and uncertainty, is now over.

So, at least, I like to tell myself when, out of the clear, plangent skies of evening the nightly Malignity comes punctually swooshing over my rooftop. Remembering the country-wide cellars where metallurgic Science dwells, I have no fear for this gallant fellow's turbine blades. Even his compressor, resembling as it does a porcupine spinning wildly about its tail, is no doubt safe. As for his airframe, which looks solid enough but is in fact jangling away like an old Jew's-harp, I can only hope that my colleagues in that line of business did their work as well. But by the time I reach this stage in my reflections, the gallant fellow is fourteen miles away, followed at a distance by his own noise, faint, yet pursuing, though it has no chance of ever catching him up; and I am scrabbling absentmindedly on the lawn for one or two roof-tiles. Progress must go on; and if I should have any complaint at all, it is only that I feel a slight sensation of Fatigue.

Notebook

Formation of Graphite Nodules

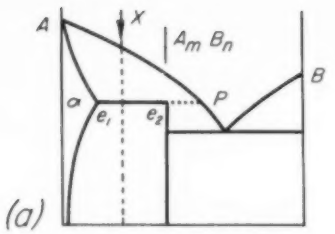
*By ALBERT DE SY**

TWO HYPOTHESES have been advanced concerning the mechanism of solidification of "nodular" iron. One holds that the graphite spherulites are born from liquid in the interdendritic pools. The other (favored by the present author) believes they are born in the solid austenite crystals near the surface. This thesis was completely developed in *Foundry* for November 1953. Further growth of nuclei into graphite nodules of considerable size will now be briefly considered.

Figure 1 represents conditions for the solidification of a binary system containing an intermetallic compound A_mB_n. The top sketch, Fig. 1 a, is the theoretical equilibrium diagram; slow cooling of an alloy of composition x to a temperature approaching the peritectic P would result in crystals of alpha solid solution saturated with element B (composition e_1) bathed in liquid of composition P. When more heat is slowly withdrawn from such a system, crystals of the compound A_mB_n form – for example, as a shell around the existing crystals of alpha solid solution (Fig. 1 b). During this peritectic transformation the concentration of B in the three phases varies somewhat as sketched in Fig. 1 c. On complete solidification the alloy consists of alpha and A_mB_n.

Now consider Fig. 2, a series of similar sketches for the solidification of iron and carbon (nodular gray iron) with the important exception that it involves a considerable degree of supercooling –

*Professor of Metallurgy, Ghent University, Belgium



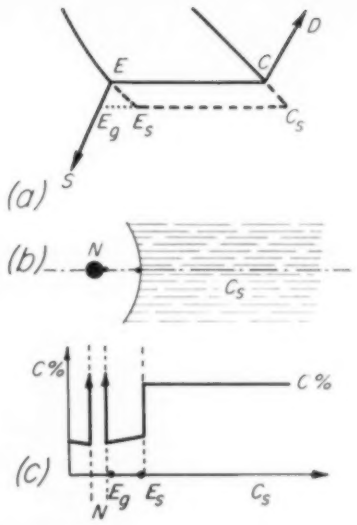


Fig. 1 – (Left) Theoretical Solidification System for Binary Alloy Forming Compound A_mB_n by Peritectic Reaction at Temperature P
Fig. 2 – (Right) Supercooling Associated With Solidification of Iron-Carbon Alloys and Mechanism of the Formation and Growth of Graphite Nodules in Primary Austenite Crystals

as noted by the dashed lines in Fig. 2 a – and consequently the austenite becomes supersaturated and acquires a carbon concentration such as E_s. Finally, because of this supersaturation, carbon is precipitated at numerous points close to the crystal's surface, since a relatively high carbon concentration gradient exists there. Thus, all the spherulites are born in a very short time near the beginning of the "eutectic arrest". The present writer believes this should be considered as a peritectic transformation or reaction.

On this basis Fig. 2 b and 2 c, analogous to Fig. 1 b and 1 c have been drawn. N represents a small graphite nucleus, and Fig. 2 c represents carbon concentrations in the three phases. Note the concentration gradients (which are the driving force for carbon migration), the completion of the peritectic transformation, and the growth of the graphite nodules.

It is unnecessary to expatiate on the similarities between Fig. 1 and Fig. 2. It may be surmised that as the distance between embryonic nodule and surface of its enclosing mass of austenite becomes greater, there is a tendency for other spherulites closer to the solid-liquid interface (the source of most of the carbon) to be born. Thus, solidification continues until the liquid phase is exhausted.

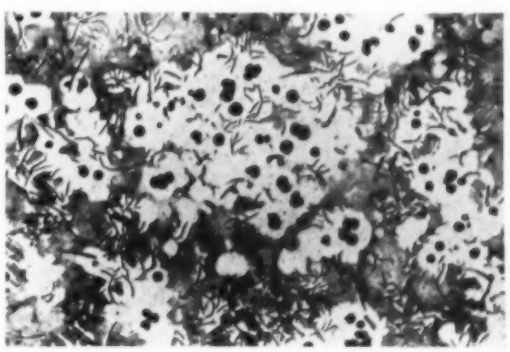
Usually, if not always, the final liquid (enriched with impurities) solidifies as a normal eutectic wherein small graphite flakes form on later cooling. These tiny flakes may usually be found in nodular irons, and it is the author's belief that they are responsible for the low impact values of some apparently first-class castings, especially those of large size.

When nodulizing treatment is only partial, as in the micrograph of Fig. 3, solidification *starts* as outlined in Fig. 2 but, as soon as the liquid phase becomes sufficiently enriched in impurities (oxygen, in the writer's opinion), graphite starts to precipitate in the molten portion and the system completes solidification as a normal eutectic action for flake graphite.

Theory Explains Characteristics

In conclusion we may say that – whatever may be the genesis of the nodule – when the graphite particles are yet very small (perhaps less than 2 microns in diameter) they start to grow within the solid austenite by a mechanism analogous to a peritectic transformation. This explains several well-known characteristics of nodular iron such as (*a*) high shrinkage, (*b*) the shape of the cooling curves, (*c*) pronounced segregration, (*d*) dendritic solidification and (*e*) flotation of nodules in hypereutectic compositions without the formation of kish.

Fig. 3 – Mixture of Nodules and Flakes in Mottled Iron (Partially Nodulized)



Induction Heating Generators as Production Tools

*By PETER A. HASSELL**



Fig. 1 – Induction Heating for Re-Flowing of Electrolytically Deposited Tin on Steel Strip in the Manufacture of Tin Plate

The success of the high-frequency heating industry will depend not only upon the continuing improvement of generator design, but also the development of new applications and better and faster methods of handling. Some design considerations and typical installations are described.

INDUCTION HEATING has now become a recognized process in almost every metalworking industry. In the fabricating and heat treating of metal parts, it helps to produce articles better, faster and cheaper. We must go back to the 1800's for a look at this production tool which has only recently received industry-wide recognition.

The basic principle of the process is electromagnetic induction, which was discovered in 1831 by Michael Faraday. High-frequency equipment for heating metals was described in several patents prior to 1860. The first high-frequency converters were spark-gap units used to heat metallic crucibles in small melting operations. In the early 1900's attempts were made to use 60 cycles for various applications such as heating wheel hubs and bearing races, and in 1917 the first production melting furnace was installed at the Bridgeport Brass Co. for melting nonferrous metals at power-line frequencies.

It was not until the 1930's that induction heating became recognized as a production tool for heat treating. Early applications were for hardening crankshaft bearings, wheel hubs, and cylinder liners. These and other operations led to the development of high-frequency motor-generator sets capable of outputs up to 1500 kw., with frequencies as high as 9600 cycles per sec. Today high-frequency motor-generators produce more kilowatts for induction heating than any other type of frequency conversion equipment. When reliable vacuum tubes became available, the development of vacuum tube oscillators for both induction and dielectric heating became practical.

*Application engineer, induction heating, Westinghouse Electric Corp., Chicago. This paper was originally presented to the Institute of Radio Engineers Professional Group on Industrial Electronics.

Electronically, the industrial radio-frequency generator is a simple device, consisting of a basic Class "C" oscillator with rectifier power supply, necessary controls, and protective devices. Although an offspring of the radio broadcast transmitter, design considerations by necessity are quite different. Operating conditions in metal fabrication dictate the need for simplicity, ruggedness, and flexibility.

Simplicity is a virtue recognized by most users. The number of controls and adjustments should be as few as possible to simplify job set-up. Simplified circuits and easy accessibility to all parts of the generator are of prime importance, since maintenance in many plants must be performed by plant electricians who are not familiar with complex electronic apparatus.

Mechanical construction is highly important. In industrial plants the generator may be subjected to vibration and mechanical shock from nearby machine tools, punch presses, shop trucks and overhead cranes. Where equipment is operated near heat treating furnaces or forge presses, allowances must be made for high ambient temperatures. Insulators and clearances between parts of different electrical potentials must be chosen with full consideration to the inevitable dust, dirt, and oily films present in machine shops and heat treating plants.

Metalworking operations performed with induced heat include melting, heat treating to obtain specific mechanical properties, heating for the movement of metal in forming, forging and upsetting, and joining of parts and assemblies by brazing, soldering and welding. Control and output characteristics must be adjustable for heating parts which vary in material, size, shape, and temperature requirements. The industrial radio-frequency generator must operate into a wide variety of loads, most of which change electrical characteristics and impedance values during the heating cycle.

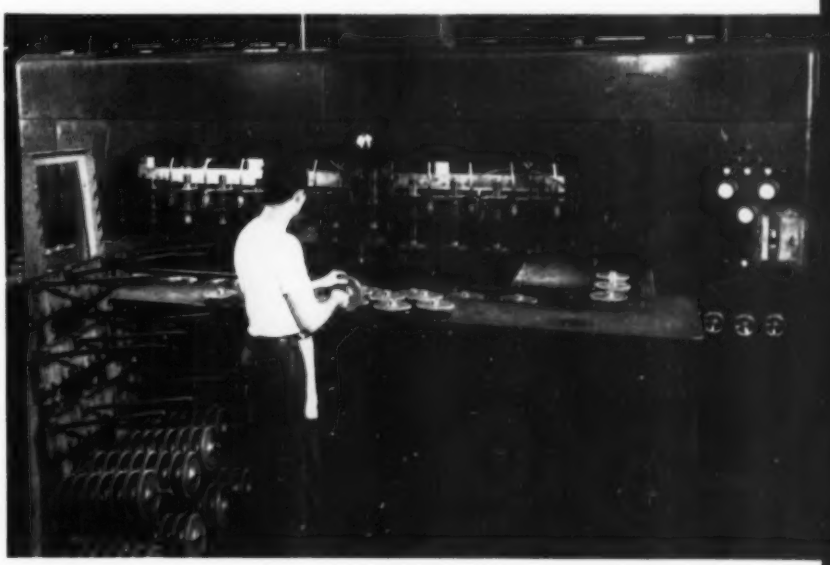
The effective use of a well-designed industrial radio-frequency generator depends upon two additional items—the heating coil or inductor, and the work-handling equipment. Design of the heating coils is a combination electrical and mechanical problem. Electrical considerations involve impedance matching, flux configuration and insulation. Mechanical considerations include clearances, support and cooling. Work handling equipment may be anything from a completely automatic self-loading machine to a simple jig, which serves primarily to position the work accurately in the heating coil. The method of getting work in and out of the coil, and degree of automation should be carefully chosen for each operation. In fact, the success or failure of an induction heating installation is often determined by the design and construction of this part of the apparatus.

Some Typical Installations

The radio-frequency heating of continuously moving steel strip for re-flowing electrolytically deposited tin is an excellent example of induction heating used as an integral part of a production process. Figure 1 shows a typical installation where strip is heated at rates up to 1800 linear ft. per min. Such installations are using over 12,000 kw. of radio-frequency energy. Mirror-bright tinned surfaces, free from porosity, are produced with one third the quantity of tin required in the hot dip process.

Another use for high-power radio-frequency heating is the hardening of spur gears used in tractor transmissions. Two frequencies are required to produce the hardness pattern which

Fig. 2—Multistation Induction Gear Hardening Installation Using One 10,000-Cycle Motor-Generator Converter and One 200,000-Cycle Vacuum-Tube Converter



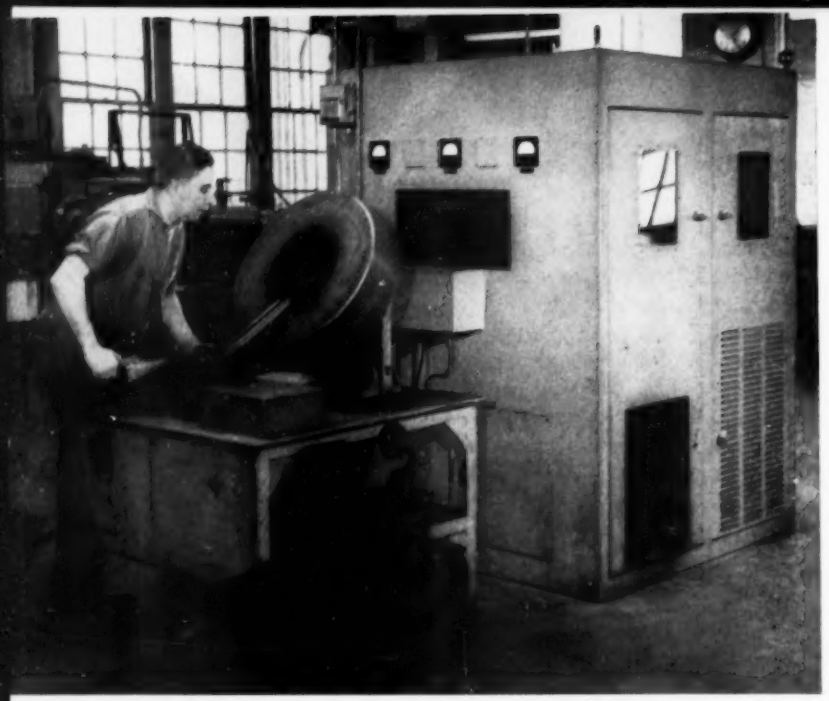


Fig. 3—Hopper-Fed Automatic Machine for Annealing Both Ends of Chain Pins

provides the most favorable mechanical stresses. Gears are first preheated to just below the hardening range with 9600-cycle power supplied by a motor-generator set. Radio-frequency power is then applied at high power density for less than a second, using a 200-kw. vacuum tube converter. This raises the tooth surfaces rapidly to the hardening temperature, and upon quenching the desired hardness contour is produced.

A typical multistation gear hardening installation using one set of high-frequency converters is shown in Fig. 2. Each station hardens one type of gears so that complete gear sets are produced continuously. Gears are loaded and unloaded automatically and one operator can easily tend five or six stations. Both 9600-cycle and radio-frequency heat is provided by one inductor or heating coil, the sequence of power application and other manipulations being automatically timed. A master control schedules the operation of the stations.

Many long, cylindrical parts such as shafts and pins are hardened on the outer surface by induction. High power densities are required for rapid surface heating, to be followed by quenching. To perform this operation with generators of reasonable size and cost, parts are "scanned", or hardened progressively. A typical machine, manufactured on machine tool principles, takes parts from a loading magazine, moves them horizontally at a predetermined rate, and rotates them as they pass through the heating coil and spray quench. Scanning rates may be up to 2 in. per sec. For selective hardening, power is applied only when the zones that require hardening pass through the heating coil.

For certain parts vertical scanning is more suitable and machines have been built which will harden shafts up to 36 in. long with manual loading and unloading. All parts are rotated to insure uniform heating and quenching. Selected areas can be hardened either by removing power or increasing the feed rate through untreated zones.

The machine shown in Fig. 3 is another example of a production tool for induction heating. It will anneal both ends of 2400 chain pins per hour. Parts are loaded into a rotary hopper which aligns and discharges them into a guide. The notched wheel picks pins from the guide and carries them through a coil which heats both ends. The entire operation is automatic, and with the human element eliminated, uniform heat treating of every part is assured.

Induction heating has done much to improve working conditions and increase production in metalworking plants. Heat treating and fabricating operations can now be placed in machining and assembly production lines, instead of being transported at much expense to a separate heat treating department. Recent significant strides have been made in the use of induction heating with machine tools; in some instances hardening is performed on the same unit which does the machining, and in others the parts pass to a completely automatic induction machine which is synchronized with the machine tool.

Radio-frequency generators do not have the kilowatt potential of motor-generator and power-line frequency equipment because they are difficult to use for heating large parts or heavy masses and because the large generator sizes are an economic disadvantage. There is a definite field for radio-frequency induction heating, however, where highly concentrated surface heat is required, particularly for parts of small diameter and cross section. Vacuum-tube oscillators can be pulse-keyed for extremely short-cycle operation and critical temperature control requirements.

A.E.C. Program for Power Development

After stating briefly the major facts of nuclear fission and the engineering problems that beset the power reactor in competition with fuel-fired plants (considerations which have been discussed in many articles in *Metal Progress* during the past ten years) Dr. Smyth outlined the Atomic Energy Commission's first reactor program.

*Early in 1949, the possibility of atomic power was attacked with a plan to build four major reactors.

The first was the materials testing reactor, MTR, primarily to get information on the effects of radiation on uranium fuel elements, tubes for cooling water, and coolants.

The second reactor built at Idaho was the so-called experimental breeder reactor, EBR, specifically aimed at demonstrating whether or not breeding was possible. It is.

The third reactor was to provide power for a submarine (submarine thermal reactor, STR). A similar reactor is now being installed in a submarine.

In all three of these reactors, the neutron economy problem was solved by using uranium from which much of the uranium-238 istotope has been extracted.

A more modest undertaking initiated later is the homogeneous reactor experiment at Oak Ridge using a solution of uranyl sulphate in which the water serves as the moderator. Its obvious advantage is that fuel fabrication and continuous purification are enormously simplified. Likewise, heat transfer: The solution is pumped continuously through the reactor chamber and an outside heat exchanger. It turned out to be self-regulating. As the temperature of the reactor rises, its reactivity decreases and therefore it controls itself.

Let me summarize some of the major results obtained in the last five years:

So far as neutron economy is concerned we have found that we can use beryllium, light water, and heavy water in addition to the familiar graphite as moderators.

As to the effects of radiation on fuel elements, the submarine thermal reactor has shown that fuel elements sheathed in zirconium will resist corrosion and radiation effects, and represent a great improvement over the aluminum-sheathed fuel elements in the Hanford reactors.

In the matter of heat transfer we have found we can remove the heat from a reactor by circulating molten sodium-potassium alloy through it, as in the EBR. We intend to use pure sodium as a coolant in the second type of "submarine intermediate reactor", SIR, now under construction near Schenectady. We are also using pressurized water in the submarine thermal reactor.

The fundamental question still to be answered is whether a power-producing uranium reactor can be built which will compete with other sources of energy. To arrive at an economical solution of the problem of nuclear power we have decided that there are six lines of investigation that the U.S. Atomic Energy Commission should pursue in a five-year program.† Obviously, one of these is the general program of research on materials, nuclear reactions, components and chemical processes. We also wish to build five reactors of varying size and cost.

The first of these is the so-called PWR (pressurized water reactor) to generate 60,000 kw. of electric power.‡ It will use slightly enriched uranium as fuel, and ordinary water as a moderator and coolant at 2000 psi. pressure and 600° F. max. in the reactor. The temperature is limited by the corrosion of the fuel elements and piping, and the pressure is limited by the vessel containing the reactor. Steam will be delivered to the turbine at about 600 psi. We have no expectation that this reactor will produce power as cheaply as a modern coal burning plant, but we hope to learn how costs can be cut in later plants.

The second new reactor is a breeder of intermediate size. The (*continued on p.* 160)

*Extracts from address by Commissioner Henry D. Smyth, U.S. Atomic Energy Commission, before American Institute of Chemical Engineers, March 9, 1954.

†The complete program is described in a Report to the Joint Committee on Atomic Energy of Congress by the Subcommittee on Research and Development, Document No. 4456 published March 1954 by the Government Printing Office.

‡Requests for industrial participation brought nine proposals from industrial firms or groups. A contract was written with Duquesne Light Co. of Pittsburgh whereby that firm will furnish a site near Pittsburgh and build the electric generating plant at its own expense (estimated at $25,000,000), operate the entire plant, contribute $5,000,000 toward the reactor portion (the equivalent of the boiler plant) and pay the A.E.C. for the heat at 48.3 to 60.3c per million Btu. in the steam entering the turbines. Westinghouse Electric Corp. will design and construct the reactor.

Automatic Carbon Control

*By HAROLD IPSEN and EDWARD J. RUPERT**

Description of instrument and principles for automatic control of carbon potential of atmospheres used in batch-type furnaces. Method uses automatic determinations of dew point to regulate flow of enrichment gas. Results are reported for carburizing and carbo-nitriding treatments for this means of control.

OF THE MANY prepared atmospheres used in the heat treatment of ferrous alloys, the most common is American Gas Assoc. Class 302† – made by the endothermic processing of gas and air – which is ideally suited for clean hardening and carburizing. A single generator is used in most heat treating arrangements to supply atmosphere for more than one furnace, with the generator output being maintained at a constant analysis suitable for heat treating in a neutral atmosphere. To change the atmosphere for carburizing or carbo-nitriding, an additional quantity of raw gas, such as propane, butane, or natural gas, must be added to each furnace to obtain a desired carbon potential. Two important ratios generally considered for control are H_2O:H_2 and CO_2:CO. A test for any one of the constituents can serve as a check of the atmosphere.

Several methods of controlling the composition of this enriching gas, and thus the carbon potential of the furnace atmosphere, used in the past include: (*a*) chemical analysis of samples of the atmosphere; (*b*) examination of microsections of samples of treated work; (*c*) dew-point determinations of the furnace atmosphere and their conversion to carbon potential by use of a graph such as shown in Fig. 1.

The objections to these methods are that they are time consuming and require a skilled operator for their execution. In addition, since these methods are only spot checks, there is no continuous record of the carbon potential during the entire process. Because the carbon potential is affected by the size of load, total surface area of the parts, temperature of the furnace, condition of the furnace, condition of the generator, and dew point of atmosphere at the generator, an automatic unit capable of indicating the carbon potential within the furnace and controlling the flow of enrichment gas is highly desirable for heat treating in production operations.

Many methods were studied and evaluated before the conclusion was reached that the greatest possibility was in the use of the dew point. The use of dew-point determinations was already accepted and practiced, and definite relationships had been charted between dew point and carbon potential. Other favorable considerations were that it is the only method that can be readily and quickly checked; no calibration is required; and it can be used for all types of processing, including carbo-nitriding. From known and tested data, carbon potential can be plotted accurately in relationship to dew point and furnace temperature.

The family of curves shown in Fig. 1, which serve as a basis for the functional aspects of the Ipsen "Carbotronik", reveal these relationships:

1. As dew point increases at a given temperature carbon potential decreases.
2. As temperature increases, dew point decreases for a given carbon potential.
3. At constant dew point, carbon potential increases as temperature decreases.

Adjustment of the dew point can be made by (*a*) changing the dew point or the flow of the carrier gas to the furnace, or (*b*) passing additive gas (for example, natural gas) to the furnace

*Mr. Ipsen is president, Ipsen Industries, Inc., Rockford, Ill., and Mr. Rupert is director of research, Ipsenlab of Rockford, Inc.

†Gas-air mixture completely reacted in catalyst-filled externally heated chamber and cooled to eliminate breakdown of CO into C + CO_2. Analysis of the mixture by volume is 39.8% N_2, 20.7% CO, 38.7% H_2 and 0.8% CH_4.

to shift the essential reaction so as to favor a low moisture content.

A long and careful investigation was launched to find suitable automatic dew-point measuring equipment. None was found to be commercially available on the market simple enough in design or universally successful under operating conditions. Attention, therefore, was then given to a manual device for measuring dew point. This was done by using bottled CO_2 as a refrigerant to cause the appearance of fog on a polished tube which was visually checked. Using this as a standard unit, a second tube was placed adjacent to the first and an electrical current was applied to it. When fog appeared, the resistance across the gap between tubes decreased, indicating that the fog was capable of carrying electricity. This was the principle on which an automatic indicating controller for the dew point was built. The CO_2 bottle was replaced by a 1/6-hp. household refrigeration unit, the polished tubes became the platinum electrodes, an electrical resistance circuit substituted for the human eye, and the bulb thermometer was replaced by an electronic instrument. The group was mounted on a panel 24x72x13 in. and is now known as the Ipsen "Dewtronik" unit (Fig. 2).

The Dewtronik has the same function as the dew-point cup, with the exception that dew points are established approximately every 5 sec. The system continuously extracts a small sample of furnace atmosphere to a cooling element. Condensation of water vapor across a narrow slot between two electrodes at the end of the cooling element completes a circuit and allows a current to flow. The electrode temperature is raised above the dew point by means of a heater around the cooling element to evaporate the dew. Thus, moisture is alternately condensed on and dissipated from the electrodes. A copper-constantan thermocouple at the electrodes measures the dew-point temperature. The Dewtronik records the dew point, and automatically regulates a motorized valve for enriching or diluting the furnace atmosphere.

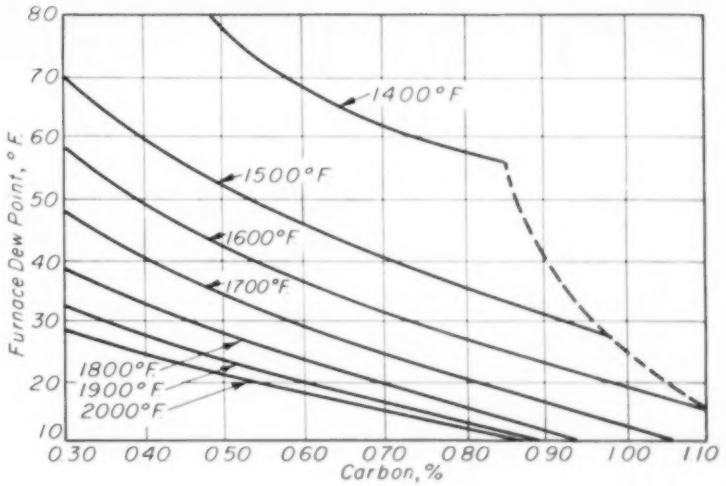
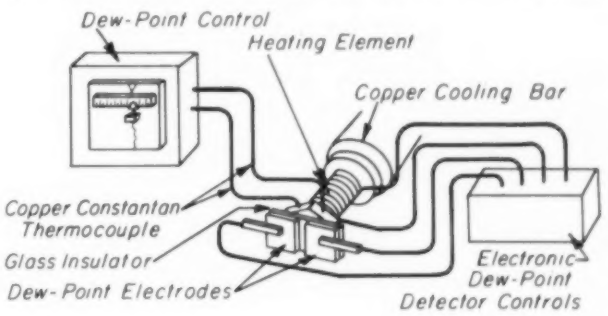


Fig. 1 — Relationship of Furnace Dew Point of Various Temperatures With Carbon Potential for Bright Hardening and Carbon Restoration Treatments

Several problems were encountered, both in manufacturing and in operation of the Dewtronik. One of the first was the removal of the atmosphere from the furnace. An industrial pump of the size required was not available, so it was necessary to design and build a small positive displacement pump capable of withstanding all types of atmosphere, including anhydrous ammonia.

A second problem, and probably one of the most difficult, was to filter solid particles, such as carbon, as well as oils from the prepared atmosphere. The former were removed readily, but the extraction of complex oily substances without removing water or moisture was a five-month project. A combination mechanical and organic filtering medium was finally used.

Fig. 2 — Schematic Circuit of Ipsen Dew-Point Control System



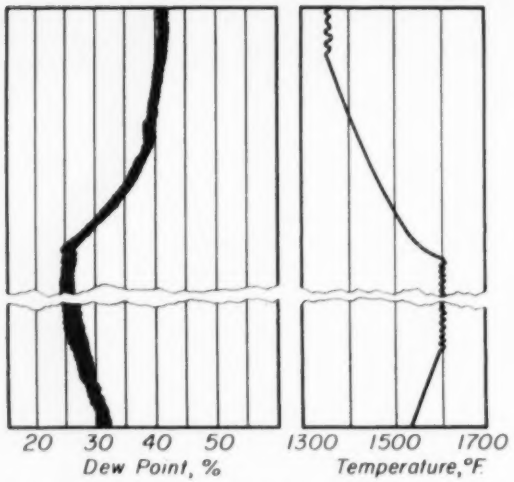


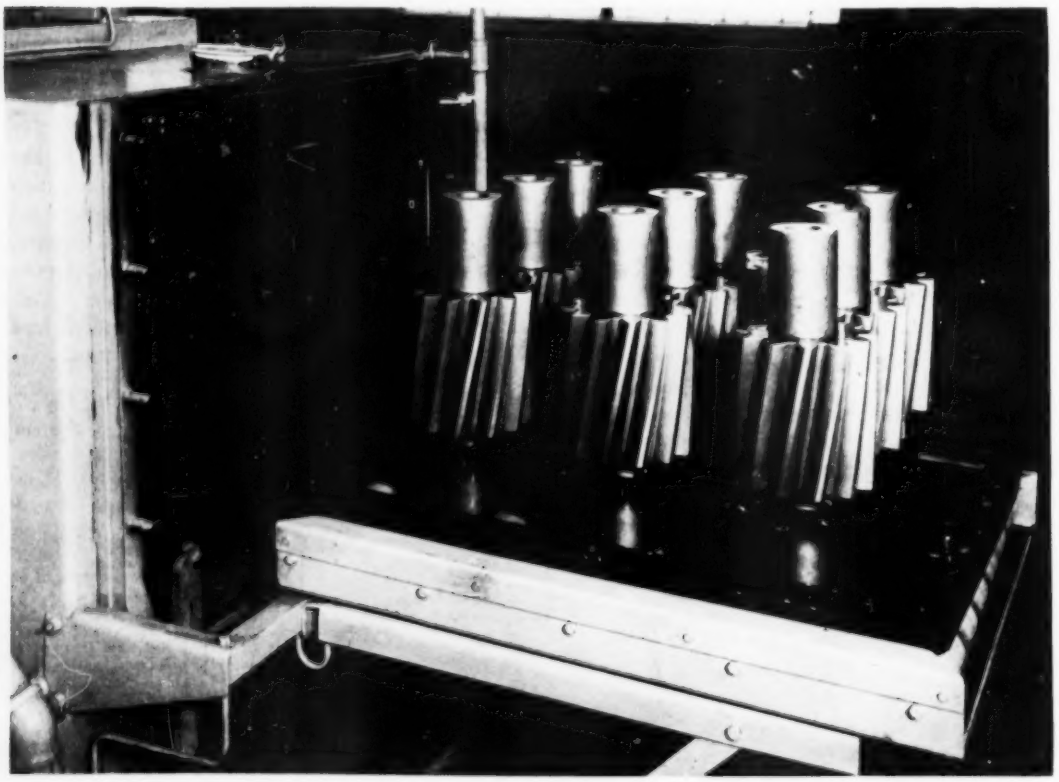
Fig. 3 – Charts for Dew Point (Left) and Furnace Temperature (Right) for Carburization of Gears, Shown in Fig. 4, to Depth of 0.020 to 0.030 In. at 1600° F. To determine the carbon potential of the atmosphere having the dew point indicated for this temperature, reference is made to the appropriate curve in Fig. 1. Note that with constant flow and a drop in furnace temperature (to 1350° F. prior to quenching), the dew point increased

The Dewtronik did not record a straight or curved line, but a high-frequency oscillation. This frequency indicated the sensitivity of the "Dewtector" and the thermocouple by showing every dew-point determination. At first this feature was regarded as objectionable, and provisions were made to dampen it out. Later, however, the oscillation was considered to be a valuable record of the performance of the sensing element.

Figure 3 is the record of the heat treatment of the gears shown in Fig. 4. These nine gears, each weighing 72 lb., were carburized at 1600° F. to a depth of 0.020 to 0.030 in., then furnace cooled to 1350° F. before quenching. 300 cu.ft. per hr. of endothermic gas was enriched with 15 cu.ft. per hr. of natural gas. The dew point of the carrier gas at the generator was maintained at 25° F.

The line plotted at the right in Fig. 3 gives the temperature within the furnace. It shows that a period of only approximately 1 hr. was needed to lower the temperature within the heating zone. This short time was realized by 100% forced convection, and by passing combustion air

Fig. 4 – 72-Lb. Gears on Unloading Rack After Bright Carburizing



through the radiant heating tubes. Dew point during the cycle is recorded by the line at the left. Note that with constant flow and a drop in temperature, dew point of the furnace atmosphere increased.

When the Dewtronik was first installed to control carbon potential in a batch-type furnace, it became necessary to add a switch to the temperature control instrument in order to prevent the enriching gas valve from operating prematurely before the furnace had reached temperature.

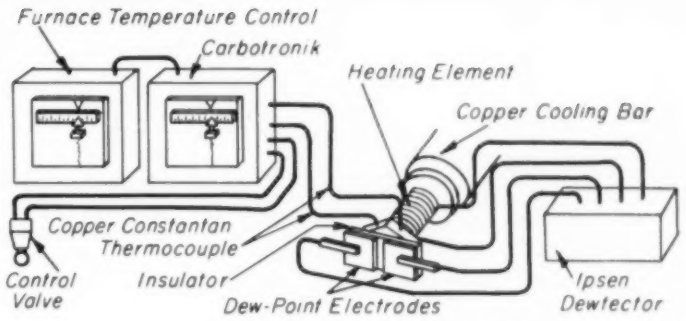


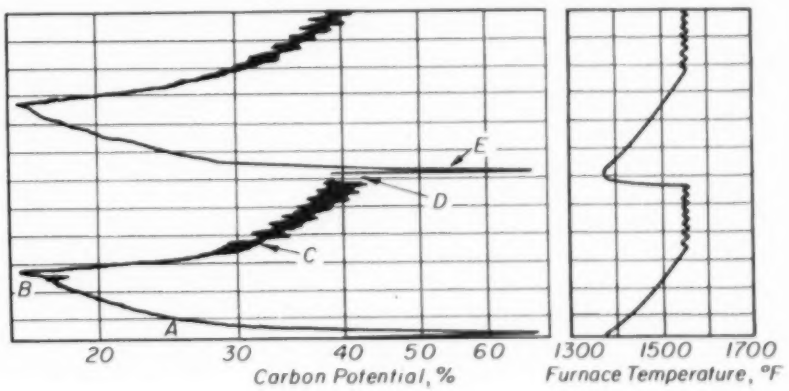
Fig. 5 – Schematic Circuit of the Ipsen Carbon Control ("Carbotronik") System

As revealed by the graph in Fig. 1, the dew point increases as temperature decreases for a given carbon potential. Therefore, to maintain a constant carbon potential when a furnace is coming up to temperature, it is necessary to change the dew point as the temperature changes. It seemed impractical to constantly change the controller setting for the dew point, so a switch was installed in the furnace temperature instrument and set at 50° F. below control temperature to prevent the control valve for the additive gas from opening.

Because time was lost in carburizing operations, it was soon apparent that direct reading of the dew point was not the best method to control furnace carbon potential (although it was ideal for controlling the generator). However, if the dew point was correlated with furnace temperature, as can be seen from Fig. 1, then we could read carbon potential directly. Therefore, a device was installed on the furnace temperature instrument to shift the dew point automatically for different furnace temperatures (as shown in Fig. 1). An inverted dew point was then changed to read in percent carbon, and the "Carbotronik" (Fig. 5) was evolved – automatically coordinating furnace temperature and dew point to give any desired carbon potential from 0.020 to 1.25%.

Figure 6 is the record of three consecutive carbo-nitriding treatments. Carbon control for carbo-nitriding was set at 45% C instead of the 80% C setting used for carburization, the hardenability effect of nitrogen compensating for the remainder of the carbon potential to produce a file-hard surface. The atmosphere was produced from 300 cu.ft. per hr. of carrier gas enriched with 15 cu.ft. per hr. of natural gas and 25 cu.ft. per hr. of ammonia. A record of the carbon potential after loading is the plot at the left in Fig. 6. The drop in dew point at the end of each cycle exceeds the speed of the recorder; this is the ragged line sloping downward and to the left and indicated by A and B. The point on the curve where the oscillation starts, identified by C, is where the furnace has reached tempera-

Fig. 6 – Charts for Carbon Potential (Left) and Furnace Temperature (Right) for Consecutive Carbo-Nitriding Treatments, the Record of Carbon Potential Being Obtained With Carbotronik Instrument in Which Dew-Point Temperature Is Compensated so That Carbon Is Read Directly. Ragged trace A to B is drop in dew point exceeding speed of recorder; C corresponds to point where furnace is at temperature; D is 2-min. delay for quenching and reloading furnace, with only chart drive in operation; E records dew point of gas left in system as affected by furnace temperature compensation of 175° F.



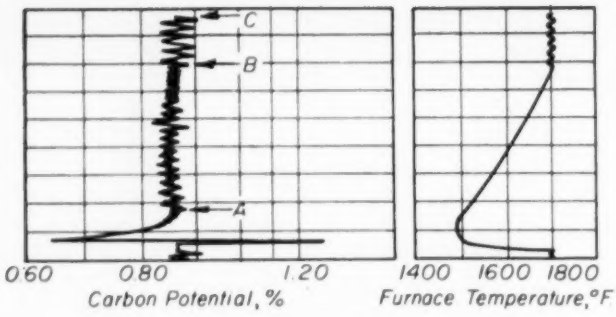


Fig. 7 – Record of Shallow Case Carburizing Cycle, A to B Being the Period of Adjustment for Dew Point as Furnace Came to Temperature, B to C the Holding Period at Temperature During Which Fluctuations in Temperature About Control Point Caused the Pronounced Oscillations in Trace for Dew Point

ture. The oscillations are of the same frequency as on the temperature chart and are the shifting of the dew point caused by temperature change.

When a new load is inserted into the furnace, the Carbotronik is turned off for 2 min. (the chart drive remains in operation as indicated by the break in record at D). This keeps the atmosphere that is contaminated with oil and water from passing through the sampling lines, and by leaving the chart drive running, the chart can readily be compared to the furnace temperature chart, since they both travel at the same rate.

The needle-like line, E, which runs to the right and occurs after the 2-min. delay, is furnace temperature compensation of approximately 175° F. and is the dew point of the gas left in the system from the previous load. It is interesting to note that although the processed work had the proper case and case depth, the carbon potential had not reached its maximum even at the time of quenching. Further investigation is being conducted on this phase.

However, there was still another problem to be solved. When straight heat treating was attempted with the Carbotronik, the enriching gas control valve, which had already been adjusted for carburizing, had too large a flow. Rather than install two valves, a solenoid-operated valve was installed in the line along with a pressure reducer in a by-pass line. A three-position selector switch was placed on the panel. When set at *Heat Treating*, all the enriching gas passed through the pressure reducer, and when the motorized valve was fully open, the flow meter indicated 15 cu.ft. per hr. maximum. When set at *Carburizing*, the solenoid valve became energized and allowed full line gas pressure to pass through, indicating 35 cu.ft. per hr. of natural gas. The valve operates with a moving piston. By removing material to shape the cylinder to a cone, any flow desired can be obtained within the range of the valve body. A spring-loaded seat also prevents flow when in the off position. It is well realized that different furnaces and different gases will require modification of the control valve and different setting of the pressure reducer.

An experiment was conducted to determine the time for the carbon potential to change in the furnace when enriching gas is introduced at the control panel. An on-off solenoid valve was installed to control the natural gas additions to the carrier gas. The flow was set for a maximum of 35 cu.ft. per hr. and 400 lb. of A.I.S.I. 1117 steel cams were loaded into the furnace. Fig. 7 is the record of the shallow case carburizing cycle. Even with the 2-min. delay and time lost in purging, the carbon potential was at the control point (0.88% C) before the temperature of the load was starting to rise. The first set of oscillations, A to B, is the result of over and under shooting caused by the rapid reaction of the furnace atmosphere to the enriching gas addition or deletion; the last oscillations, B to C, are caused by the small fluctuations of the furnace temperature about the control point.

The Carbotronik maintains the carbon potential regardless of temperature. The temperature shifting of the scale can be noted by the low-frequency oscillation occurring on the Carbotronik after the furnace temperature has reached the holding stage and in cycling at control point within ± 10° F.

The unit is effective over a range of 0.20 to 1.25% carbon, and over a temperature range from 1400 to 2000° F. Accuracy is maintained at ±0.02% C – far more accurate than required.

Use of the Carbotronik and Dewtronik gives the following information:

1. Indicates degree of furnace conditioning.
2. Records the amount of contamination resulting during loading.
3. Indicates the purging time required for change in process.
4. Responds to the requirements imposed by load and surface area.
5. Permits achieving specified carbon content.
6. Provides a permanent record.

Operation of the Ipsen Carbotronik equipment is simple, and does not require calibration, only periodic cleaning.

Annealing of Titanium

*By E. R. FUNK**

Proper temperature for annealing cold worked titanium sheet was appraised by pre-straining tensile samples, annealing 1 hr., and then pulling to fracture. Best annealing temperature (1100° F.) gave highest total strain.

TITANIUM sheet is now being fabricated into various aircraft parts by the more or less conventional blanking, forming and drawing operations. "Cold" work of this sort hardens and stiffens the metal. Exactly as in the working of soft steel sheet, there is a limit to the deformation that can be safely endured; once this is overstepped the parts will either break in process or lock up so much internal stress that slight additional loads in service will cause fracture. Also as in conventional practice, this "exhausted ductility" can be restored by annealing – a short heat treatment at moderate temperature.

In our work at Goodyear Aircraft Corp. with titanium Type Ti 75 A (nominally 0.1 Fe, 0.02 N, 0.04 max. C, 0.08 max. W) it was desirable to know the relationship between amount of cold work, annealing temperature and time, and amount of elastic recovery – all of which are interrelated in a process anneal.

In most experiments on annealing and recrystallization of metals, the strain prior to annealing is introduced by cold rolling – probably the most convenient of the available methods. A sheet originally 0.010 in. thick, for example, cold rolled to 0.009 in. would be said to be strained 10%. Since this is a compressive action and since most straining in sheet metal forming is by extension, it is somewhat more realistic to *stretch* the samples under test.

Consequently, a large number of 0.020-in. thick tensile test specimens were prepared. These specimens of Ti75A titanium sheet were 0.5 in. wide with a relieved area sufficiently long to attach an extensometer with a 2-in. gage length. By careful loading, these test specimens were given a predetermined amount of plastic tensile strain. The specimens were then annealed in an air furnace for one hour at various temperatures and finally pulled to failure at room temperature. The amount of strain to fracture after annealing, added to the initial strain prior to annealing, could be compared with the total strain to fracture of unannealed specimens. In this manner

*Engineering Consultant, Goodyear Aircraft Corp., Akron, Ohio

the effectiveness of the annealing treatment could be determined.

True Strain – Since the results are dependent upon the addition and comparison of strain, the strain must be true strain and not engineering strain. By "true strain" is meant the natural logarithm of the ratio between cross-sectional area of the specimen before and after a given stress is applied, whereas "engineering strain" means the stretch per unit length.

The derivation of the above definition of true strain is quite simple. If a bar originally of length l is loaded lightly it is stretched a small amount dl and the resulting infinitestimal strain is

$$d\varepsilon = dl/l.$$

When more load is applied, the strain becomes finite and the strain is evaluated by integrating this equation between the limits l_0 (the original length) and l_1 (the final length). Such an integration results in the following equation

$$\text{Strain } \varepsilon = \ln \frac{l_1}{l_0}$$

which is to say that the true strain is measured by the natural logarithm of the ratio of final to original length of the bar.

This expression can also be evaluated in terms of cross-sectional area because it may be assumed that the *volume* of the metal remains constant and is only redistributed by plastic deformation. Accordingly,

$$V_1 = A_1 l_1 = V_0 = A_0 l_0$$

where A_1 and A_0 are the final and original cross-sectional areas respectively. From the above relationship, it can readily be seen that

$$l_1/l_0 = A_0/A_1$$

Thus, the equation for true strain can be written

$$\varepsilon = \ln A_0/A_1$$

which gives us the statement made at the beginning of this section, that true strain is the natural logarithm of the ratio between cross-sectional area of the specimen before and after a given stress is applied. The cross-sectional areas are determined from measurements of the width and thickness of the specimen taken at the minimum cross section at the time.

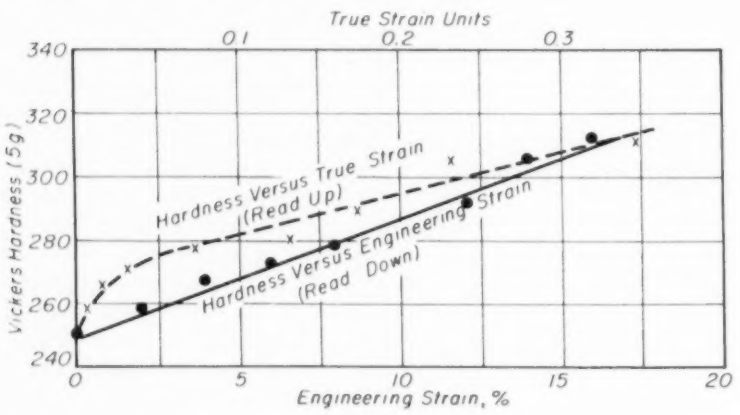
In contrast to the usual engineering strain, true strains are additive – that is, the sum of the parts equals the whole.

True Stress – Two methods of calculating stress are also in use which are the complements of the true strain and engineering strain. The "engineering stress" is the one commonly used in reporting data; the load is divided by the original area of the specimen to compute the stress. When flow or necking begins as a result of plastic yielding, the original area is no longer the area which carries the load and the engineering stress therefore becomes increasingly in error.

This error can be eliminated if one uses the actual area of the specimen at the time. Thus the formula for "true stress" is the load divided by the actual area.

Although the true stress is an accurate measure of the unit stress actually being experienced by the specimen, taking the data is complicated by the fact that diameter or thickness and width must be measured simultaneously with each load reading. On the other hand, data for engineering stress need only the original area and the loads during the experiment. Since only the load is recorded, it is clear that the engineering stress is in direct proportion to the load. Thus, "engineering stress" is a direct measure of the load-supporting ability of a specimen. This property is of prime interest to designing engineers, while the "true stress" is of more interest to scientific experimenters.

Fig. 1—Vickers Hardness of Titanium Increases With Strain. Hardness measured in necked region of tensile specimens made of 0.020-in. Ti75A sheet



Experimental Data— Standard sheet metal tensile specimens of Ti75A were carefully strained various amounts. The aim was to introduce into each of 10 specimens strains from 2 to 16% in steps of 2%. This resulted in 80 specimens. Temperatures were chosen rang-

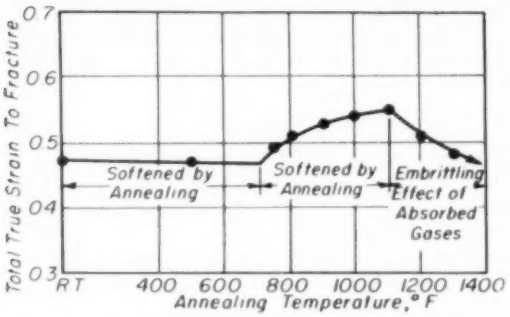


Fig. 2—Appraisal of 1-Hr. Annealings by Plotting Temperatures Against Total True Strain to Fracture. Optimum for Ti75A is 1100° F.

ing from 500 to 1300° F. so a series of specimens each one having a different amount of pre-strain could be heated for 1 hr. to the various temperatures.

Before describing the results we might mention the hardness measurements on the necked region after pre-straining. The average of several readings is presented in Fig. 1 where the Vicker's pyramid hardness (5-g. load) is plotted against engineering strain and true strain.

Thickness and width of test specimens were measured with micrometers and thumb dial indicator. After the pre-strain the necked region was surveyed with the thumb dial indicator until the narrowest width was found, and measurements at this location were used to determine the true pre-strain. After fracture the width was determined at the apparent minimum width. A sample calculation for specimen No. 44 follows:

Original area = 0.502 × 0.021 = 0.0105 sq. in.
Area after pre-strain = 0.465 × 0.020 = 0.00930 sq. in.
True pre-strain = ln 0.0105/0.00930 = ln 1.13 = 0.22
Area after fracture = 0.320 × 0.020 = 0.00640 sq. in.
True strain after anneal = ln 0.00930/0.00640 = ln 1.45 = 0.372
Total strain to fracture = 0.122 + 0.372 = 0.494
Temperature of anneal = 1300° F.
Time of anneal = 1 hr.

Conclusions – In spite of the large amount of data, the results can be presented in a single curve, shown in Fig. 2. Inherent inadequacies of the method are rather large. For example, seven samples were pulled to fracture in condition as received (no pre-strain, no anneal) and the true strain at fracture was computed at 0.482, 0.464, 0.470, 0.432, 0.425, 0.425, and 0.451, or an arithmetical mean of 0.450 plus 0.032 minus 0.025. The samples which were pre-strained and then pulled to destruction *without* any anneal developed a total true strain of 0.509, 0.490, 0.455, 0.460, 0.482, 0.451 and 0.451, an arithmetical mean of 0.471 plus 0.038 minus 0.021. (This figure is plotted on the RT or room temperature ordinate in Fig. 2.)

Similarly the ten specimens given an engineering pre-strain of 14% showed a variable true pre-strain or measurement – namely, 0.344, 0.157, 0.210, 0.195, 0.197, 0.278, 0.197, 0.210, 0.255, 0.262, an arithmetical mean of 0.230 plus 0.114 minus 0.035.

Our experiments therefore did not detect the known decrease in "annealing temperature" with increased amounts of cold work – by "annealing temperature" is meant that temperature where the original ductility is restored (within reasonable time). A trend in this direction was detectable, but the scatter in the data was too great to be analyzed by a plot. A part of the scatter resulted from the fact that the amount of true pre-strain introduced varied considerably from the intended values, set by extension of the specimen a given amount. Such a scatter is noted in the figures quoted in the preceding paragraph for engineering pre-strain of 14%.

Our data confirm, in a general way, that the softening in this annealing range is greater at higher pre-strain values. For example, the total true strains to fracture (after annealing 1 hr. at 1200° F.) for various pre-strains are as follows:

Pre-Strain	Strain to Fracture	Total Strain
0.020	0.453	0.473
0.030	0.457	0.477
0.041	0.489	0.530
0.053	0.445	0.499
0.104	0.399	0.503
0.178	0.378	0.556
0.210	0.278	0.480
0.300	0.262	0.562

Averaged data, as plotted in Fig. 2, show three definite regions of great concern to fabricators of titanium. At temperatures below 700° F., no annealing (softening) occurs. As the temperature increases, the amount of softening increases up to about 1100° F. Above 1100° F., the embrittling effect from the pick-up of oxygen and nitrogen begins to overshadow the softening effect of the heat, and above 1350° F. the sum total of the heating in air is detrimental. This effect of exposure of titanium to oxygen and nitrogen at elevated temperatures has been discussed in the recent technical literature.

Optimum softness without danger of embrittlement is assured by stress relieving Ti75A at 1100° F. for 1 hr.

Book Review

Monograph on Aluminum

*Reviewed by FRANK G. NORRIS**

Aluminum in Iron and Steel, by Samuel L. Case and Kent R. Van Horn. 478 p. Alloys of Iron Research Monograph Series. Published by John Wiley & Sons, Inc., New York, for the Engineering Foundation. $8.50.

This latest monograph in the Alloys of Iron Research series deals with more than aluminum in iron and steel. In fact, it considers a vast area of the entire field of metallurgy and also has philosophical and epistemological implications. It is not written by the authors alone, for they have assembled information from the world technical press. Yet it is more than a compilation or review. Many tables and charts of original data are provided so that the discerning student can form his own conclusions, free from the possible bias of discussion or interpretation.

In the same sense that the book was not written by the authors, it can be said that it has not been read by the reviewer. The entire book has been scanned, it has been browsed, only part of it has been read, some parts have been reread and others studied. That is the kind of book it is. Reading it straight through would be a formidable task, something like reading an encyclopedia. Many readers will find that the introductory discussion at the beginning of each chapter and the summary furnish an easy way to bring one's general information up to date.

As a background for the discussion of this book an informal survey was recently made by noting the response to three words. To the word "Brinell", most people replied "hardness". (Some said "Rockwell".)

To the word "Carnot" practically all of the engineers said "cycle", which, of course, is the expected reply. (Some variants were "car yes" or "how do you spell it?")

To the word "aluminum" there were a wide variety of replies. The only definite pattern was the universal indication that everyone was familiar with the term and had used aluminum in some way. Some said "deoxidize", some said "killed", some said "metal", some said "paint" or "siding", some said "company", and some said "pots and pans".

Now, reverting to the first response to "Brinell", it is interesting to surmise Brinell's opinion of this reaction to his name some 50 years after his investigation of porosity in ingots. There is some ground to believe that Brinell's primary purpose was to compare various deoxidizers in their effect on the structure and properties of steel. Hardness was one (but only one) of these properties. In order to study hardness he contrived a device which was so successful that it is now regarded by some as his major accomplishment. The halo of Brinell's influence illuminates many of the pages of this book by Case and Van Horn. It is the type of book he would probably enjoy browsing through, lingering here and there to nod in confirmation or to wonder at new discoveries.

Carnot, on the other hand, was an idealist. He showed how a gas could be made to do useful work and be returned to its initial conditions of temperature and pressure. A cynic might say, "How can you expect to get anywhere just going around in circles (or cycles)?" With full realization that analogies are treacherous, let us think for a moment of the cycle of expansion and condensation of information and of the useful work that results. *Truth* presumably is the constant corresponding to the weight of gas that does not change during the cycle. *Data* represent various aspects of the truth which are revealed from time to time by investigators using ingenious methods. The volume expands with the *publication* and description of the data; the articles are indexed and abstracted and the abstracts *indexed*. Then a book is published and is now being reviewed. Ultimately reference to this book review will appear in an *index*.

The cynic may ask, "Isn't all of this paper work just going around in circles?" The idealist knows

*Mr. Norris is on the general staff of Wheeling Steel Corp. His title (metallurgical engineer—statistics) gives little inkling of his wide knowledge of openhearth steelmaking as practiced in American tonnage shops.

that the cycle isn't ideal, that something has been lost. The philosopher wonders in the sense that he stands in awe. Has truth been increased, or is it only our understanding that is helped by decreasing the effort of search and increasing the accessibility of known information?

Finally, the unpredictable response to the word "aluminum" suggests the wide range of interest that is covered in this book. When it is considered that, of all the metals, aluminum is second only to silicon in abundance, and that iron and steel are the metals used in the greatest amounts, it is not surprising that the intersection of these two fields is itself an area of no mean extent. Any book carries the imprint of the background of the author (in this case, the united backgrounds of both authors). Even though the title suggests a limited scope, and even though the authors have stayed within these bounds, the book has a broad appeal to both theoretical and practical aspects of all of metallurgy and much of physical chemistry. It is virtually impossible to think of any topic pertaining to the general field of metallurgy that is not discussed or alluded to in this book. Write down ten subjects that come to your mind. Then look for reference to them in this book. It is an interesting pastime.

A vast amount of material (341 bibliography references) has been logically arranged and competently presented. Covering, as it does, such a wide field of interest, the question may arise, "Is this book suitable for a text; either for a formal class or for home study for those who wish to keep abreast of the 'revolution that took place in metallurgical thinking regarding the role played by aluminum . . . during the war years and immediately after'?" Quite likely it would be a difficult book to use for a text. A handful of pearls has a certain value and beauty. How much more beautiful they become when strung into a necklace! The general subject "aluminum in iron and steel" is the thread of continuity that enhances the beauty of the many gems of information assembled here. In what better way could the interdependence of many subjects be shown? The fatal disconnection of subjects does much to kill the vitality of our modern curriculum. The suggestion that the text is difficult leads, of course, to the comment of one of the great philosophers of our times, Alfred North Whitehead: "Whenever a textbook is written of real educational worth, you may be quite certain that some reviewer will say that it will be difficult to teach from it."

The preparation of a book review is a heady elixir that can easily cause one to veer from the middle course of discretion and either ascend to the heights of inordinate praise or fall into the ditch of carping pickiness. It may be best to evade the question "Is this a good book?" by recalling the remark of the melancholy Dane, "There is nothing either good or bad, but thinking makes it so; to me it is a prison."

The obvious parallel is, "Aluminum in steel is neither good nor bad, but intent (or specification) makes it so; to some it is a poison."

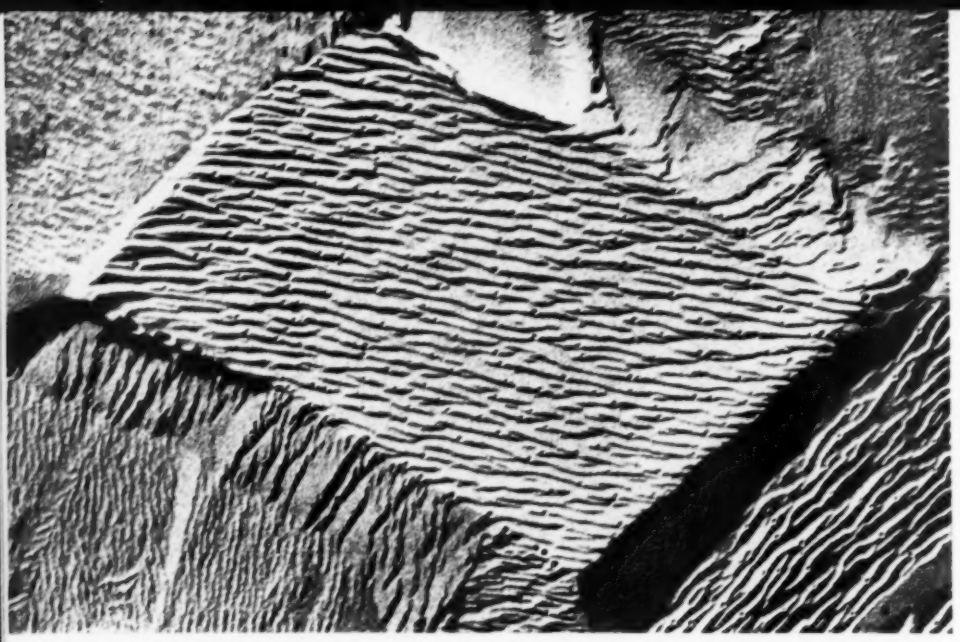
The importance of intent is illustrated by considering hardness. In carburized steel, for example, soft spots are the source of considerable concern, as are hard spots in soft steel intended for deep drawing. Compare this thought with the quotation from page 407: "The selection of a process for the aluminum coating of steel should be influenced by the expected service of the coating as well as by economic considerations."

How simple general principles seem when finally unraveled from obscuring details and explained by a master! Consider the concept of normality given in the quotation from page 110:

"The terms normal and abnormal, while often applied to steels, are really descriptive of the structure obtained under certain carburizing conditions rather than of a property of the steel. Both types of structure may be found in adjacent areas in a single steel specimen. The same steel may produce an abnormal structure when box carburized with a solid carburizing compound, and a normal structure when gas carburized."

Yet how frequently the steelmaking process has been blamed for producing abnormal steel. If an investigation is carefully planned and well executed can it be said to be fruitless merely because the results are negative? Were the man-hours wasted that were spent looking in the openhearth for conditions present in the carburizing box?

A book that provides factual answers and also stimulates the reader to ask as many questions as are answered provides an interesting pastime, a profitable source of information, and a provocative inspiration to further study. And so, after having thumbed hastily through this book, pausing to read a few of the high spots, past knowledge appears in just a little different light. Brinell suggests a man who set out to study deoxidation and along the way did that which most of us remember. Carnot suggests that information as well as substance passes through an ideal cycle. Aluminum suggests almost anything according to our background of experience.



Electron Micrograph at 23,000 × of Type 322 Stainless, Etched With the New Technique

Cathodic Vacuum Etching

*By T. R. PADDEN and F. M. CAIN, JR.**

New design of equipment using zirconium fittings and cooled cathode reduces etching time to one to three minutes in standardized routine and handles difficult compacts and couples as easily as the common metals and alloys

When a metal is made the cathode in a vacuum glow discharge, subjecting it to positive ion bombardment, some of the metal is ejected from the surface. The dislodged atoms diffuse through the gas and deposit on the walls of the vacuum system or on the electrodes. This process, usually called "sputtering", has been used for many years to form films of metal for various purposes such as the coating of mirrors. The removal of the metal from the cathode surface is not completely random but is related to the microstructure of the cathode; the resulting etched surface is similar in appearance to surfaces produced by chemical or electrochemical etching. This specific application of sputtering to the development of the macrostructure and microstructure of metallographic specimens has been termed "cathodic vacuum etching".

The glow discharge is established by applying a high potential between two electrodes in a partial vacuum and can be maintained under a variety of conditions of pressure, types of residual gas, electrode dimensions, and temperature, as well as potential, current and degree of current rectification. Since the primary purpose of cathodic vacuum etching is to reveal the microstructures without change or without introducing any artifacts, the experimental conditions must be properly chosen.

A very useful and versatile technique has been developed which fulfills these requirements. Etching times are of the order of 1 to 3 min. as compared with 1 to 3 hr. using previously described techniques. A description of the equipment and procedure, together with typical optical and electron micrographs, is presented in this article.

*Westinghouse Atomic Power Division, Bettis Field, Pittsburgh. The work was done under contract AT-11-1-Gen-14 with the U. S. Atomic Energy Commission.

Literature Review – J. Strong in "Procedures in Experimental Physics" reviewed a number of sputtering investigations. (See reference 1 in the bibliography on p. 164.) Although most of these studies were carried out under conditions unsuited to cathodic vacuum etching, the results can be used as a guide. For example, the sputtering rate of silver increases with gas atmosphere in the order helium, hydrogen, nitrogen, and argon; it increases a little less than linearly with voltage, and a little more than linearly with sputtering current (depending somewhat on the other experimental conditions). Tables are included in Strong's article ranking a number of metals according to their sputtering rates under various conditions. A discussion of the theories of cathode sputtering is available in literature references 2, 3 and 4 (p. 164). In several empirical equations the sputtering rate of a metal is related to an inverse function of its heat of sublimation or its total heat of evaporation.

Feitknecht[5] in 1924 developed microstructures of a number of nonferrous metals and although the sample surfaces showed many artifacts, he established the feasibility of the technique. C. S. Smith[6] in 1927 described a fast and simple cathodic vacuum etching procedure, but the contrast of the resulting microstructures was dependent upon preferential staining concurrent with etching. D. McCutcheon[7] revived interest in the technique in 1949 and shortly thereafter[8] he and W. Pahl in *Metal Progress* for November 1949, p. 679, demonstrated the usefulness of this method in the development of "flow-lines" in forgings. They also showed that cathodic vacuum etching revealed microstructures which sometimes were superior in quality to those obtained with chemical etchants and that this technique was particularly good for highly alloyed materials difficult to etch chemically. T. F. Fisher and C. E. Weber[9] described equipment and a procedure using purified krypton. While this was designed primarily for sputtering, they observed that when operating their equipment at very low power their maximum cathode temperature was 325° C. (615° F.) and that contrast between different grains and phases in samples of zirconium, titanium, and beryllium was obtained in their system when it was used in a manner analogous to that described by McCutcheon.

The most promising procedures have been lengthy, usually requiring etching times of at least one hour and often special precautions to insure gas purity.

Equipment Design – Our cathodic vacuum etching equipment is similar to previous designs in some respects, while some of its other features enable us to use an etching procedure which is much faster and more versatile than those previously described.

The equipment was designed around a conventional evaporator of the type used for shadowing in electron microscopy. The vacuum system consists of a 12-in. bell jar, mechanical pump, diffusion pump, roughing vacuum line, needle valve, and discharge gage. The high-voltage source is a 5000-volt, 50-milliamp. full wave rectified direct-current power supply with a positive ground and a 60,000-ohm current limiting resistor. The general arrangement is shown in Fig. 1. The cathode is suspended from the top of the bell jar and the anode mount rests on the evaporator base plate. These are shielded so that an isolated glow cell is operated within the vacuum chamber. The desired gas pressure is maintained in the bell jar by estab-

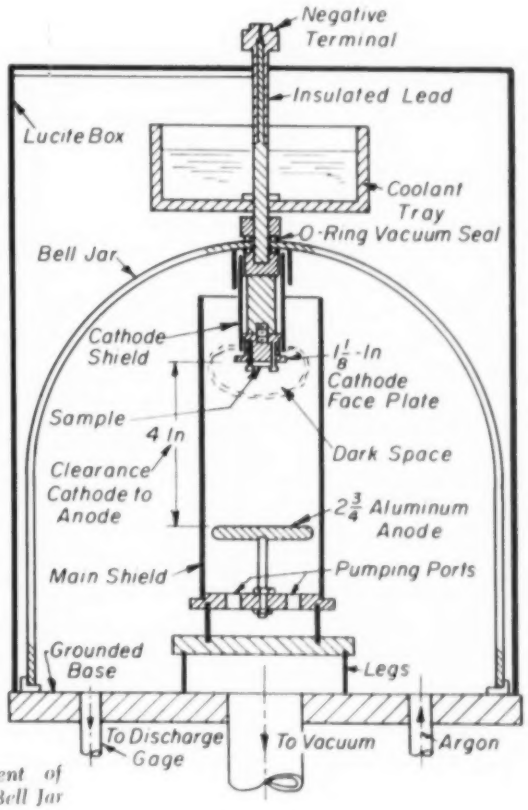


Fig. 1 – General Arrangement of Components in 12-In. Pyrex Bell Jar

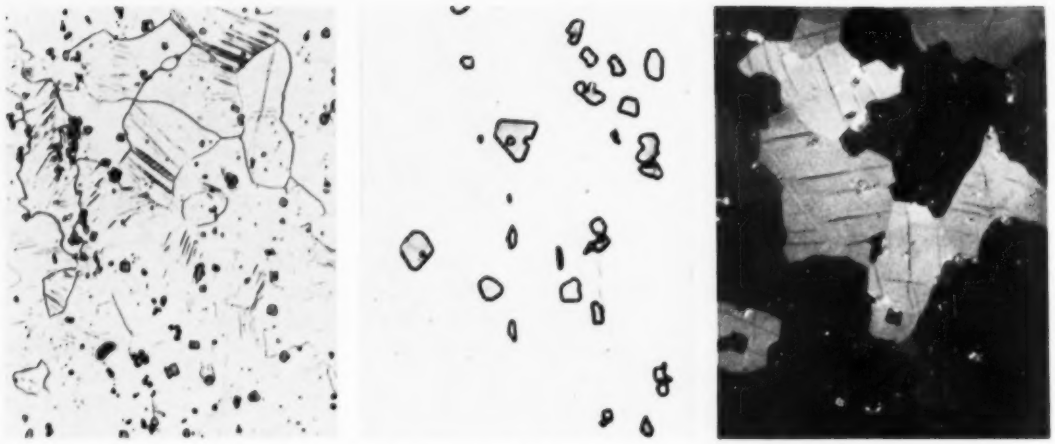


Fig. 2 – Microstructure of Uranium. Left – metal rolled below alpha to beta transition. Cathodically vacuum etched for 3 min.; 250×. Center – metal as at left after annealing 100 min. at 700° C. (1290° F.). Cathodically vacuum etched for 1 min.; 500×. Right – same metal as center, electrolytic polish in chromic-acetic solution. Photographed under polarized light; 250×

lishing a dynamic equilibrium between the pumping speed and a controlled argon leak through the needle valve.

The cathode is designed so high current densities can be used (resulting in much shorter etching times) without excessively heating the sample, and so the etching conditions can be standardized although the samples used are of various sizes and shapes. The cathode consists of a face plate, 1.125 in. in diameter, the sample, and bolts for clamping the two together. The effective area of the cathode is fixed; therefore the electrical conditions for etching can be standardized. Fittings were made from zirconium and aluminum because of the slow etching rates of these metals.

With the electrical conditions standardized, the cooling requirements are fixed and the cathode can be cooled with the simple arrangement shown in Fig. 1. Heat is conducted from the cathode mount to an external heat sink by copper fittings; a mixture of dry ice and trichloroethylene is the coolant. With this arrangement the sample is always below 450° F. (230° C.) – a temperature determined by etching a sample of pure tin which did not melt in 6-min. exposure. The cooling time after ion bombardment is adjusted so that the sample is just above room temperature when removed, thus eliminating the possibility of condensation from the atmosphere.

If the bottom of the glass shield surrounding the cathode mount is in contact with the face plate, the glass is attacked and there are sudden current surges which overload the relay and cut off the power. With the cathode mount shielded as shown in Fig. 1, these difficulties are eliminated and etching is confined to the sample and the cathode fittings.

The aluminum anode (2.75 in. diameter) is placed 4 in. from the cathode, so it is far outside the "Crookes dark space" for the electrical conditions and vacuum existing. Consequently, most of the sputtered metal deposits on the easily cleaned, cylindrical glass shield surrounding the electrodes.

As a further precaution against contaminating the evaporator, the anode and mount are made in the form of a baffle which inhibits diffusion of any metal vapor that escapes deposition on the shield. During operation, everything is enclosed in a lucite box, leaving only the insulated high-voltage connector exposed. This box serves the dual purpose of protection from accidental collapse of the bell jar and electrical shock.

This equipment is designed so the variables can be changed easily; however, one set of geometrical, electrical and pressure conditions was satisfactory for all but one sample tried thus far, a silver-cadmium alloy which etched too fast for the standard procedure.

Procedure – A sample with one of two parallel faces mechanically polished is clamped to the cathode face plate with the polished face exposed. Shields are adjusted and the bell jar is placed in position. The system is pumped to about 1 micron and then flushed several times with argon. The pressure in the bell jar is then

adjusted to 50 microns. Dry ice and trichloroethylene are loaded into the coolant tray and the power supply warmed up, and after about 3 min. the high-voltage is applied by setting the power control. Initially the voltage across the glow cell is about half the predetermined maximum and, as the conductivity of the cell changes, the resistance of the glow cell in relation to the current-limiting resistor also changes, resulting in an increase in voltage across the cell and a drop in current. When the voltage reaches a steady value, deposition of metal on the glass shield is observed; this induction period is from 0.5 to 2 min. "Etching time" commences with the electrical steady state; it is usually between 1 and 3 min. The high voltage is turned off and argon supplied to bring the jar to atmospheric pressure. The sample is removed and is ready for microscopic examination.

The complete procedure requires about 20 min.

Metallographic Applications

In order to demonstrate the utility of cathodic vacuum etching as a metallographic tool as well as to show its versatility, a variety of materials were tested: *(a)* unalloyed nonferrous materials, *(b)* alloys, *(c)* complex materials, *(d)* dissimilar metal couples.

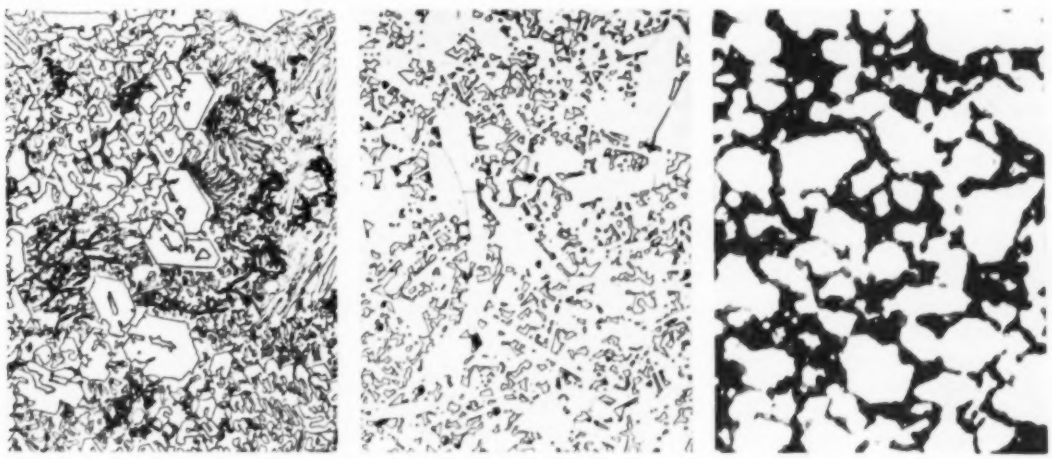
In general, the microstructures were similar to those which might be expected from nonstaining chemical etchants; consequently, their interpretation is similar. Contrast was always good and staining was absent. Results were usually appreciably better than obtained with chemical and electrochemical etchants as used in this laboratory. Specimens were best observed with bright-field illumination, although samples of zirconium also displayed excellent structural detail under polarized light.

The micrographs in Fig. 2 exemplify some of the particular advantages of cathodic vacuum etching. It is quite difficult to develop the microstructure of uranium by other methods without pitting the inclusions or staining the surface. With our standardized cathodic vacuum etching procedure, however, these objectives can be readily attained. Furthermore, the depth of the etch can be adjusted by varying the etching time, so that etching for short times can be used as a routine preparation for cleanliness ratings.

A 70-30 silver-cadmium alloy is the only sample tried thus far which could not be etched conveniently with the standard procedure. The etching rate was so fast that the depth of the etch could not be controlled. The power input could have been lowered to slow down the etching rate in argon, but it was of more interest to introduce air and compare the etching rates at the same power (and consequently the same temperature range). Its etching rate in air was considerably less than in argon – the etching rate increases with increase in the mass of impinging ions.

The illustration at the beginning of this article is from an electron micrograph of a Type 322 stainless steel, age hardened at 1050° F. (565° C.) for 45 min. and cathodically vacuum etched for 4 min. It was made from a parlodion negative replica, stripped dry from the surface and shadowed with uranium. Although the useful-

Fig. 3 – Etching of Complex Structures. Left – graphitic Stellite; 150×. Center – carbide; 83% chromium carbide, 15% nickel binder; 250×. Right – ceramet; 70% chromium, 30% alumina; 400×



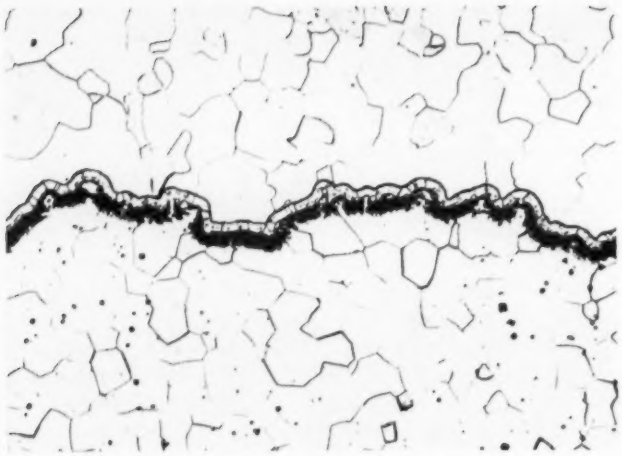


Fig. 4 – Interface Between Zirconium (Top) and Uranium Alloy (Bottom); 250×

ness of the new etching method to electron metallography has not been thoroughly investigated, its probable utility is indicated by the detail developed in this sample, and the wide applicability of this technique to conventional metallography.

In addition to the four materials mentioned previously the technique has been applied to copper, nickel, aluminum, cupronickel and silicon bronze.

Figure 3 further demonstrates the general applicability to complex materials. They are particularly interesting since they contain phases which range from good electrical conductors to nonconductors. The graphite in the Stellite, the chromium carbide, and the alumina were all etched by ion bombardment, but in general these poorer conductors did not etch as fast as the metals.

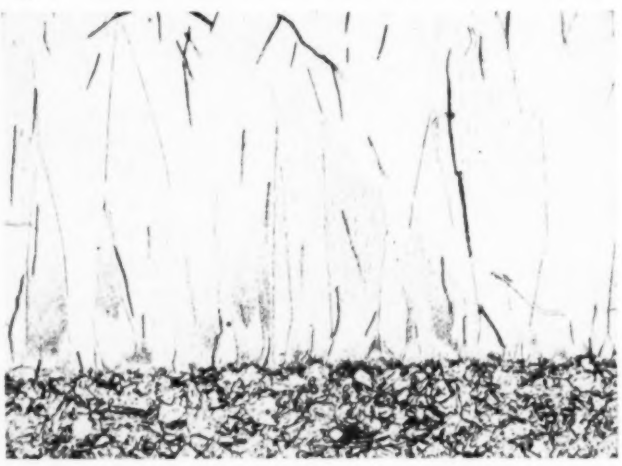
A fundamentally difficult problem existing in metallography is the preparation of dissimilar metal couples. Occasionally a single chemical etchant can be found which will serve for a particular couple; sometimes successive etching in different reagents will solve the problem, but often the etchant for one component will pit or obliterate the structure of the other and attack the interface by galvanic action. On the contrary, cathodic vacuum etching appears to be nonspecific in nature, so the microstructures are developed simultaneously and the interface areas are well preserved. However, this application is limited by the relative etching rates of the materials present. For example, attempts to etch a couple between a 70-30 Ag-Cd alloy and stainless steel (as well as a galvanized iron) failed due to a great difference in height across the interface.

Excellent results were obtained by cathodic vacuum etching of such dissimilar metal couples as zirconium on uranium alloy (Fig. 4) cupronickel on Type 347 stainless and hard facing on stainless. Structures of both materials in each sample were developed in detail and the interface areas are well preserved.

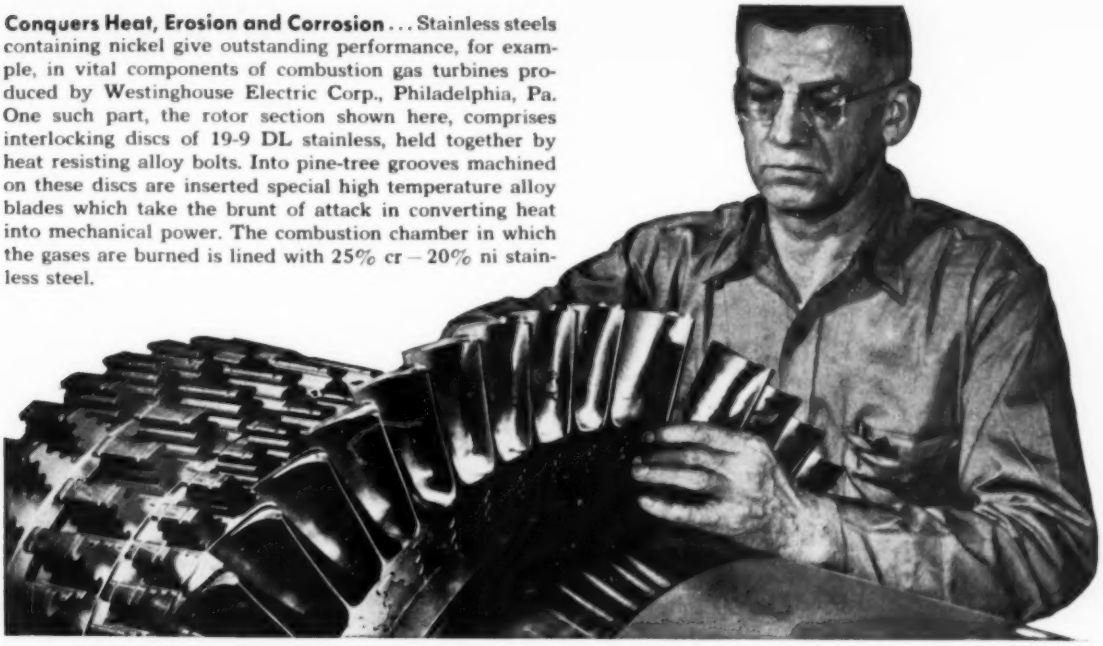
Another good example is Fig. 5 – hard chromium plate on stainless steel 17-4 PH (17% Cr, 4% Ni, 4% Cu). Note that in addition to the usual cracks seen in hard chromium plate, cathodic vacuum etching has developed the columnar grain structure.

Additional Applications – Cathodic vacuum etching has other possibilities, such as removing oxides from intricately shaped metal pieces and preparing standard surfaces for corrosion studies. This etching technique should be especially suited to electron microscopy since there are no apparent etching byproducts, and preshadowed replicas could be made of an etched surface that has been exposed only to an argon atmosphere. Etching of nonconductors, such as ceramics, for microstudy is another possible application of the method. (*Continued on p.* 162)

Fig. 5 – Hard Chromium Plate on 17-4 PH Stainless; 400×



Conquers Heat, Erosion and Corrosion . . . Stainless steels containing nickel give outstanding performance, for example, in vital components of combustion gas turbines produced by Westinghouse Electric Corp., Philadelphia, Pa. One such part, the rotor section shown here, comprises interlocking discs of 19-9 DL stainless, held together by heat resisting alloy bolts. Into pine-tree grooves machined on these discs are inserted special high temperature alloy blades which take the brunt of attack in converting heat into mechanical power. The combustion chamber in which the gases are burned is lined with 25% cr – 20% ni stainless steel.



STAINLESS PROVIDES THE ANSWERS . . .

Thousands of designers and engineers have found austenitic chromium-nickel stainless steels to be the key to new high standards of product performance and minimum operating costs. You, too, may find that a stainless steel containing nickel will help solve *your* metal problem.

1. At Elevated Temperatures

Stainless steels of this type possess the two essential qualities for successful use at elevated temperatures. By virtue of the chromium content, and assisted by the nickel content, they have outstanding resistance to scaling and oxidation. The nickel content also results in high creep strength and stress-to-rupture properties. Combined, these properties permit use of chromium-nickel stainless even in thin sections required for lightweight design.

2. At Sub-Zero Temperatures

Experience has shown that unalloyed steels become embrittled rapidly as temperature is lowered below normal. Nickel is by far the best alloying element to prevent brittleness. At sub-zero temperatures, chromium-nickel stainless steels provide unsurpassed impact values. These steels retain such a high level of toughness that they are known to be useful at temperatures as low as —400° F. and possibly even lower.

3. Under Corrosive Conditions

Selection of exactly the right alloy for your specific needs may be made from some thirty alloy steels qualified to carry the family name "Stainless." By virtue of their strength and resistance to attack by chemicals and atmospheres over a wide range of concentrations and temperatures, these austenitic chromium-nickel steels assure not only longer life of the equipment and purity of product, but also permit decrease of bulk and deadweight without sacrificing safety.

4. Where Erosion Is A Problem

Chromium-nickel stainless offers the utmost in resistance to erosion and cavitation. By cold working, it is possible to increase the tensile strength to as much as 300,000 psi. When subjected to erosion, the erosive media work hardens the surface and, correspondingly, curbs the attack. This resistance to erosion combined with corrosion resistance results in prolonged life for equipment made from the chromium-nickel stainless steels.

5. Use *Stainless* To Meet Complex Requirements

Utilize the unique combination of properties provided by chromium-nickel stainless steels when designing new products or improving old ones. You can draw, spin, forge, weld, solder, punch, shear or bend chromium-nickel stainless steels. Leading steel companies produce these austenitic alloys in all commercial forms. A list of sources of supply will be furnished on request.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

A.I.S.I. Standard Alloy Steel Compositions [a]

A.I.S.I. List Revised February, 1954

Openhearth and Electric Furnace Alloy Steels

(Bars, billets, blooms and slabs up to 200 sq.in., 18 in. wide or 10,000 lb.)

A.I.S.I. Number [b]	C	Mn	Ni	Cr	Mo
1330	0.28-0.33	1.60-1.90	.....	.....	.....
1335	0.33-0.38	1.60-1.90	.....	.....	.....
1340	0.38-0.43	1.60-1.90	.....	.....	.....
1345	0.43-0.48	1.60-1.90	.....	.....	.....
2317	0.15-0.20	0.40-0.60	3.25-3.75	.....	.....
2515	0.12-0.17	0.40-0.60	4.75-5.25	.....	.....
E2517 [c]	0.15-0.20	0.45-0.60	4.75-5.25	.....	.....
3120	0.17-0.22	0.60-0.80	1.10-1.40	0.55-0.75	.....
3130	0.28-0.33	0.60-0.80	1.10-1.40	0.55-0.75	.....
3135	0.33-0.38	0.60-0.80	1.10-1.40	0.55-0.75	.....
3140	0.38-0.43	0.70-0.90	1.10-1.40	0.55-0.75	.....
E3310 [c]	0.08-0.13	0.45-0.60	3.25-3.75	1.40-1.75	.....
E3316 [c]	0.14-0.19	0.45-0.60	3.25-3.75	1.40-1.75	.....
TS4012	0.09-0.14	0.75-1.00	.....	.....	0.15-0.25
4023	0.20-0.25	0.70-0.90	.....	.....	0.20-0.30
4024 [d]	0.20-0.25	0.70-0.90	.....	.....	0.20-0.30
4027	0.25-0.30	0.70-0.90	.....	.....	0.20-0.30
4028 [d]	0.25-0.30	0.70-0.90	.....	.....	0.20-0.30
4032	0.30-0.35	0.70-0.90	.....	.....	0.20-0.30
4037	0.35-0.40	0.70-0.90	.....	.....	0.20-0.30
4042	0.40-0.45	0.70-0.90	.....	.....	0.20-0.30
4047	0.45-0.50	0.70-0.90	.....	.....	0.20-0.30
4053	0.50-0.56	0.75-1.00	.....	.....	0.20-0.30
4063	0.60-0.67	0.75-1.00	.....	.....	0.20-0.30
4068	0.63-0.70	0.75-1.00	.....	.....	0.20-0.30
4118	0.18-0.23	0.70-0.90	.....	0.40-0.60	0.08-0.15
4130	0.28-0.33	0.40-0.60	.....	0.80-1.10	0.15-0.25
TS4130	0.28-0.33	0.45-0.65	.....	0.90-1.20	0.08-0.15
TS4132	0.30-0.35	0.45-0.65	.....	0.90-1.20	0.08-0.15
4135	0.33-0.38	0.70-0.90	.....	0.80-1.10	0.15-0.25
4137	0.35-0.40	0.70-0.90	.....	0.80-1.10	0.15-0.25
TS4137	0.35-0.40	0.75-1.00	.....	0.90-1.20	0.08-0.15
4140	0.38-0.43	0.75-1.00	.....	0.80-1.10	0.15-0.25
TS4140	0.38-0.43	0.80-1.05	.....	0.90-1.20	0.08-0.15
4142	0.40-0.45	0.75-1.00	.....	0.80-1.10	0.15-0.25
TS4142	0.40-0.45	0.80-1.05	.....	0.90-1.20	0.08-0.15
4145	0.43-0.48	0.75-1.00	.....	0.80-1.10	0.15-0.25
TS4145	0.43-0.48	0.80-1.05	.....	0.90-1.20	0.08-0.15
4147	0.45-0.50	0.75-1.00	.....	0.80-1.10	0.15-0.25
4150	0.48-0.53	0.75-1.00	.....	0.80-1.10	0.15-0.25
TS4150	0.48-0.53	0.80-1.05	.....	0.90-1.20	0.08-0.15
4320	0.17-0.22	0.45-0.65	1.65-2.00	0.40-0.60	0.20-0.30
4337 [e]	0.35-0.40	0.60-0.80	1.65-2.00	0.70-0.90	0.20-0.30
4340	0.38-0.43	0.60-0.80	1.65-2.00	0.70-0.90	0.20-0.30
E4340	0.38-0.43	0.65-0.85	1.65-2.00	0.70-0.90	0.20-0.30
4608 [f]	0.06-0.11	0.25-0.45	1.40-1.75	.....	0.15-0.25
4615	0.13-0.18	0.45-0.65	1.65-2.00	.....	0.20-0.30
4617	0.15-0.20	0.45-0.65	1.65-2.00	.....	0.20-0.30
4620	0.17-0.22	0.45-0.65	1.65-2.00	.....	0.20-0.30
X4620	0.18-0.23	0.50-0.70	1.65-2.00	.....	0.20-0.30
4621	0.18-0.23	0.70-0.90	1.65-2.00	.....	0.20-0.30
4640	0.38-0.43	0.60-0.80	1.65-2.00	.....	0.20-0.30
TS4720	0.17-0.22	0.50-0.70	0.90-1.20	0.35-0.55	0.15-0.25
4812	0.10-0.15	0.40-0.60	3.25-3.75	.....	0.20-0.30
4815	0.13-0.18	0.40-0.60	3.25-3.75	.....	0.20-0.30
4817	0.15-0.20	0.40-0.60	3.25-3.75	.....	0.20-0.30
4820	0.18-0.23	0.50-0.70	3.25-3.75	.....	0.20-0.30
5015	0.12-0.17	0.30-0.50	.....	0.30-0.50	.....
5046	0.43-0.50	0.75-1.00	.....	0.20-0.35	.....
5117	0.15-0.20	0.70-0.90	.....	0.70-0.90	.....
5120	0.17-0.22	0.70-0.90	.....	0.70-0.90	.....
5130	0.28-0.33	0.70-0.90	.....	0.80-1.10	.....
5132	0.30-0.35	0.60-0.80	.....	0.75-1.00	.....
5135	0.33-0.38	0.60-0.80	.....	0.80-1.05	.....
5140	0.38-0.43	0.70-0.90	.....	0.70-0.90	.....
5145	0.43-0.48	0.70-0.90	.....	0.70-0.90	.....
5147	0.45-0.52	0.70-0.95	.....	0.85-1.15	.....
5150	0.48-0.53	0.70-0.90	.....	0.70-0.90	.....
5152	0.48-0.55	0.70-0.90	.....	0.90-1.20	.....
5155	0.50-0.60	0.70-0.90	.....	0.70-0.90	.....
5160	0.55-0.65	0.75-1.00	.....	0.70-0.90	.....
E50100	0.95-1.10	0.25-0.45	.....	0.40-0.60	.....
E51100	0.95-1.10	0.25-0.45	.....	0.90-1.15	.....
E52100	0.95-1.10	0.25-0.45	.....	1.30-1.60	.....
6117	0.15-0.20	0.70-0.90	.....	0.70-0.90	0.10 min. V
6120	0.17-0.22	0.70-0.90	.....	0.70-0.90	0.10 min. V
6145	0.43-0.48	0.70-0.90	.....	0.80-1.10	0.15 min. V
6150	0.48-0.53	0.70-0.90	.....	0.80-1.10	0.15 min. V
TS8115	0.13-0.18	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8117	0.15-0.20	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8120	0.18-0.23	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8122	0.20-0.25	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8123 [d]	0.20-0.25	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8125	0.23-0.28	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8126 [d]	0.23-0.28	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8127	0.25-0.30	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
TS8128 [d]	0.25-0.30	0.70-0.90	0.20-0.40	0.30-0.50	0.08-0.15
8615	0.13-0.18	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
TS8615	0.13-0.18	0.70-0.90	0.30-0.60	0.55-0.75	0.08-0.15
8617	0.15-0.20	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
TS8617	0.15-0.20	0.70-0.90	0.30-0.60	0.55-0.75	0.08-0.15
8620	0.18-0.23	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
TS8620	0.18-0.23	0.70-0.90	0.30-0.60	0.55-0.75	0.08-0.15
8622	0.20-0.25	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
TS8622	0.20-0.25	0.70-0.90	0.30-0.60	0.55-0.75	0.08-0.15
8625	0.23-0.28	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
TS8625	0.23-0.28	0.70-0.90	0.30-0.60	0.55-0.75	0.08-0.15
8627	0.25-0.30	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
TS8627	0.25-0.30	0.70-0.90	0.30-0.60	0.55-0.75	0.08-0.15
8630	0.28-0.33	0.70-0.90	0.40-0.70	0.40-0.60	0.15-0.25
8635	0.33-0.38	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8637	0.35-0.40	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8640	0.38-0.43	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8641 [d]	0.38-0.43	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8642	0.40-0.45	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8645	0.43-0.48	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
86B45 [h]	0.43-0.48	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8650	0.48-0.53	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8653	0.50-0.56	0.75-1.00	0.40-0.70	0.50-0.80	0.15-0.25
8655	0.50-0.60	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8660	0.55-0.65	0.75-1.00	0.40-0.70	0.40-0.60	0.15-0.25
8715	0.13-0.18	0.70-0.90	0.40-0.70	0.40-0.60	0.20-0.30
8717	0.15-0.20	0.70-0.90	0.40-0.70	0.40-0.60	0.20-0.30
8720	0.18-0.23	0.70-0.90	0.40-0.70	0.40-0.60	0.20-0.30
8735	0.33-0.38	0.75-1.00	0.40-0.70	0.40-0.60	0.20-0.30
8740	0.38-0.43	0.75-1.00	0.40-0.70	0.40-0.60	0.20-0.30
8742	0.40-0.45	0.75-1.00	0.40-0.70	0.40-0.60	0.20-0.30
8750	0.48-0.53	0.75-1.00	0.40-0.70	0.40-0.60	0.20-0.30
9255 [g]	0.50-0.60	0.70-0.95	.....	.....	.....
9260 [g]	0.55-0.65	0.70-1.00	.....	.....	.....
9261 [g]	0.55-0.65	0.75-1.00	.....	0.10-0.25	.....
9262 [g]	0.55-0.65	0.75-1.00	.....	0.25-0.40	.....
E9310	0.08-0.13	0.45-0.65	3.00-3.50	1.00-1.40	0.08-0.15
E9314	0.11-0.17	0.40-0.70	3.00-3.50	1.00-1.40	0.08-0.15
9840	0.38-0.43	0.70-0.90	0.85-1.15	0.70-0.90	0.20-0.30
9845	0.43-0.48	0.70-0.90	0.85-1.15	0.70-0.90	0.20-0.30
9850	0.48-0.53	0.70-0.90	0.85-1.15	0.70-0.90	0.20-0.30

NOTE *(a)* — All chemical ranges and limits are subject to the standard variations for check analysis over or under specification.

NOTE *(b)* — Numbers with prefix E are generally made in basic electric furnaces and unless otherwise noted the following specifications hold: Phosphorus 0.025% max., sulphur 0.025% max., silicon 0.20 to 0.35%.

Numbers without letter prefix are ordinarily made in basic openhearth furnaces and unless otherwise noted the following specifications hold: Phosphorus 0.040% max., sulphur 0.040% max., silicon 0.20 to 0.35%.

Specification limits for the acid electric and acid openhearth processes are: Phosphorus 0.050% max., sulphur 0.050% max., silicon 0.15 to 0.35%.

In all processes the maximum allowable quantities of unspecified and incidental elements are as follows: 0.35% copper, 0.25% nickel, 0.20% chromium and 0.06% molybdenum.

Numbers with prefix TS represent tentative standards designed to conserve strategic alloys.

NOTE *(c)* — When this steel is made in openhearth furnaces the manganese is 0.40 to 0.60%.

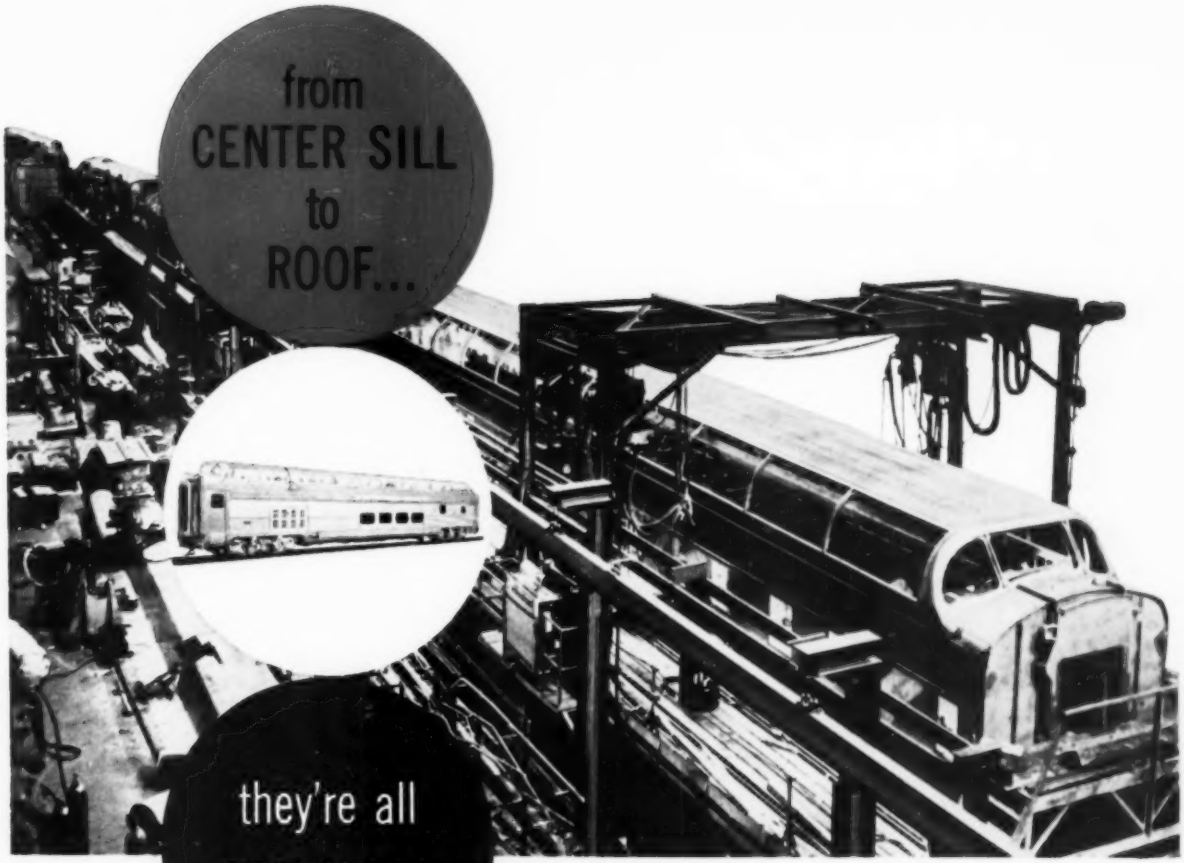
NOTE *(d)* — Resulphurized steels; sulphur is 0.035 to 0.050% except in 8641 where it is 0.040 to 0.060%.

NOTE *(e)* — When this steel is made in electric furnaces the manganese is 0.65 to 0.85%.

NOTE *(f)* — Silicon is 0.25% max.

NOTE *(g)* — Silico-manganese steels; silicon range is 1.80 to 2.20%.

NOTE *(h)* — This steel can be expected to have 0.0005% min. boron.



These full-length dome cars are part of an order for 121 being built by The Budd Company for the Santa Fe Railway. They feature not only unexcelled facilities for passenger enjoyment . . . but also the *safety and economy* of Crucible Rezistal® stainless steel.

Because they're *all stainless* — their strength-weight ratio is higher than you'd find in low alloy carbon steel. The cars are *lighter yet stronger* than ordinary steel cars, which means the Santa Fe will be able to haul as many as 25 of these cars with the same drawbar pull they'd need for 20 low alloy carbon steel cars.

What's more, the passive surface of Crucible stainless will never need painting . . . never need more than a "once-over-lightly" by maintenance crews to keep its sparkling new look. And, beneath the skin, where corrosion and vibration can undermine the strength of vital structural members — the high corrosion resistance and fatigue strength of Crucible stainless will keep these cars in service for a lifetime.

Budd would not have chosen stainless for all the cars they build unless it was a *practical shop metal*. And it is. For it can be formed, machined, welded, drawn, heat-treated — processed in any way you'd normally use for ordinary steel.

So don't forget the Crucible family of stainless steels where you need corrosion resistance . . . high fatigue, creep and structural strength . . . resistance to wear and temperature extremes . . . workability. We'll be glad to help you select the best stainless grade for your job. Let our Metallurgical Engineering Department make practical suggestions.



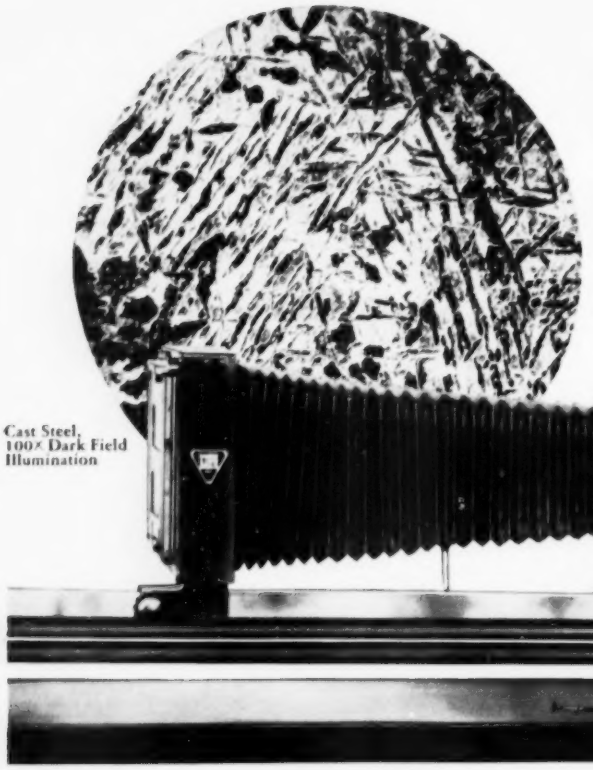
CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **STAINLESS STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.



Cast Steel,
100× Dark Field
Illumination

SPEEDS PRODUCTION

by simplifying analysis of "hard-to-see" structure

There's an efficient solution to your metallurgical problem in this complete Bausch & Lomb line:

- **Four different metallographs, ranging in use from routine bright field studies to advanced research. (Catalogs E-28, E-29, E-232, E-240)**
- **Photomacrographic Equipment Model L . . . widest low power range. (Catalog E-210)**
- **CM Metallurgical Microscope . . . industry's standard. (Catalog E-223)**
- **Stereomicroscopes . . . vivid 3-dimensional low power studies. (Catalog D-15)**
- **Eyepiece Camera . . . 35mm or 2¼″ x 3¼″ film. (Catalog E-244)**
- **Polaroid Land Camera Attachment . . . finished print in one minute! (Catalog E-243)**

Bausch & Lomb Research Metallograph

. . . Metal industry's maximum use instrument . . . helps you boost output and maintain quality by providing clear, detailed magnified images—visual or photographic—for routine work and advanced research.

You see samples better because exclusive Balcoted objectives bring out detail even in low contrast specimens. *You're sure of complete identification* because you have your choice of four different views of the same sample—by bright field, dark field, polarized light, or phase contrast; change-over is quick and simple.

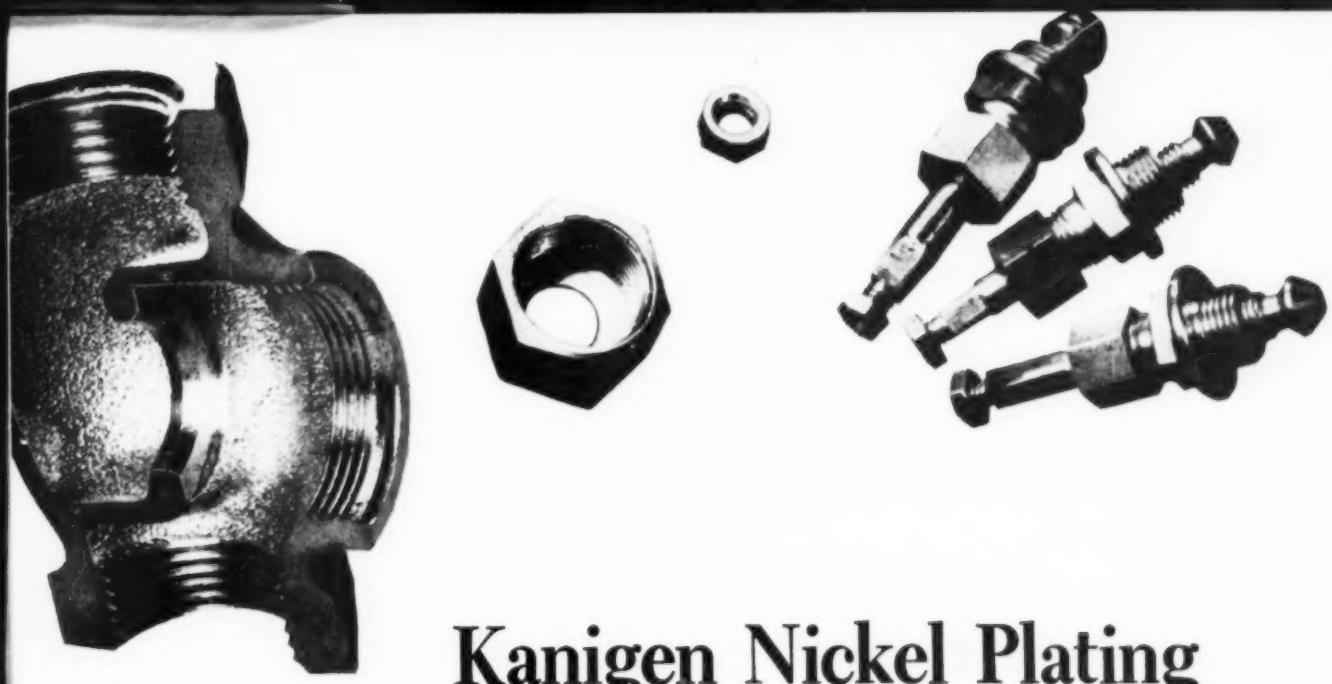
There may well be considerable savings of time and materials for your company in these faster, easier, completely dependable analyses. Why not find out now? Write for Catalog E-240.

WRITE or PHONE for complete information (specify catalog numbers) and for prompt, expert advisory service. No obligation, of course. Bausch & Lomb Optical Co., 63831 St. Paul St., Rochester 2, N. Y. Phone: LOcust 3000.

BAUSCH & LOMB

SINCE B&L 1853

METALLURGICAL EQUIPMENT



Kanigen Nickel Plating

*By GREGOIRE GUTZEIT**

The chemistry and process, characteristics, and uses of a plate deposited by an electroless method.

NICKEL PLATING by chemical catalytic action differs from electroplating in that neither current nor electrodes are required for its application. Deposition takes place at a uniform rate wherever there is contact between the part and the solution; in other words, the "throwing power" of the bath is infinite and there is no substantial variation in plating thickness, even for the most complicated shapes. The coating is a low nickel-phosphorus alloy of considerable hardness and higher corrosion resistance than electroplated nickel, and the as-plated deposit is nonporous even at less than 0.2 mil. thick.

The "Kanigen"† nickel plating process is based on the good pioneering work performed by Brenner and Riddell of the electrochemical laboratory of the U. S. Bureau of Standards,[1]‡ although the basic reaction was discovered by Wurtz in 1844[2] and a U. S. patent issued in 1916[3] disclosed qualitatively the use of solutions containing hypophosphite ions for nickel coating most base materials.

The hypophosphite anion in aqueous medium is oxidized to the phosphite ion, slowly at low temperature and rapidly at higher temperatures, while hydrogen is evolved. This oxidation takes place spontaneously (homogeneous reaction) at pH values above 7.0; but, in acid medium, the presence of a catalyst belonging to group 8 of the periodic system is required (catalytic heterogeneous reaction). The equation, according to Wurtz, Bach[4] and Brenner, is:

$$Na(H_2PO_2) + H_2O \rightarrow NaH(HPO_3) + H_2 \qquad (1)$$

If the aqueous hypophosphite solution is relatively concentrated and contains cations of heavy metals that can be reduced, such as nickel, cobalt, copper, silver and gold, a spongy metallic precipitate forms when the solution is heated.

Moreover, if the cation in solution is that of a catalytic metal, and a catalytic solid surface is immersed in it, plating will take place on this surface (provided the proper concentrations are chosen) and continue until the solution is depleted of hypophosphite ion or of its metallic cation. According to Brenner and Riddell the gross equation is:

$$NiCl_2 + Na(H_2PO_2) + H_2O \xrightarrow{\text{catalyst}} Ni^0 + 2HCl + NaH(HPO_3) \qquad (2)$$

*Associate Director, Research and Development Department, General American Transportation Corp., Chicago.

†"Kanigen" is a Trade Mark adopted by General American Transportation Corp., for its chemical nickel plating.

‡See references on p. 146.

Actually, the chemical mechanism is considerably more complex. Without going into details, it is our considered opinion that the primary reaction is a catalytic dehydrogenation of hypophosphite (determined with the use of deuterium-tagged reagents) as follows[5,6]:

$$(H_2PO_2)^- \xrightarrow[\text{catalyst}]{-2H} PO_2^- + H_2O \rightarrow H(HPO_3) \qquad (3)$$

hypophosphite ion — metaphosphite ion — orthophosphite ion

Part of the atomic hydrogen thereby formed is possibly adsorbed on the catalytic surface as a condensed layer, reducing the nickel salt to metallic nickel:

$$Ni^{++} + 2H \rightarrow Ni^0 + 2H^+$$
$$\text{or} \quad NiSO_4 + 2H \rightarrow Ni^0 + H_2SO_4 \qquad (4)$$

It is assumed that the metallic nickel immediately reacts with hypophosphorous acid (at a much slower rate) to form phosphides[7,8], as:

$$6Ni^0 + 2H(H_2PO_2) \rightarrow Ni_5P_2 + 3H_2O + NiO \qquad (5)$$

Bureau of Standards Method—Reaction 4 (respectively reaction 2) shows that the pH of the bath will decrease as plating proceeds. With increasing acidity of the bath the reducing efficiency of the hypophosphite is lowered with a resulting slowing of the reaction. Finally, when the hydrogen ion concentration becomes high enough to start dissolving the metallic deposit, plating will stop. Brenner and Riddell corrected this condition in part by adding a buffer to the plating bath. They state that the concentrations of nickel salt and of hypophosphite are not critical in acid baths, and that the effective pH range is fairly broad (4.0 to 6.5), but they established an optimum concentration range for each of the buffers.

Typical preferred acid baths according to the original Bureau of Standards laboratory method which give semibright, smooth plating have compositions as listed in Table I.

Presence of the buffers and proper dilution of the reactants allows the plating to proceed for a reasonable time, although the rates are slow. The bath will eventually decompose, this occurring in two stages: first with the formation of a rough deposit, then in complete deterioration (depletion by formation of "black precipitate"). Moreover, the results as to plating quality are quite inconsistent.

To summarize, the principal disadvantages of the Bureau of Standards method and its later commercial adaptations are:

1. Lack of stability of the plating bath in continuous work.
2. Rough and dull plating after fair start.
3. Slow plating rate.
4. Formation of a stratified (nonhomogeneous) deposit.
5. Relatively high cost.

The work carried on for over five years by the research and development department of General American Transportation Corp. had as its main purpose the discovery of an industrial process for chemical nickel plating that would not have the drawbacks of the original Bureau of Standards method. The thought originated in 1947, when our engineering department was studying the economics of electroplating a car tank with nickel for caustic soda service.

The laboratory research work was considered sufficiently advanced by late summer of 1952 and operation of a pilot plant was started in August at East Chicago, Ind. After a short experimental period, government agencies asked us to start commercial operation. In late 1953, production plants were completed in East Chicago and Los Angeles. To our knowledge and documented belief, General American's shop was the first to apply electroless plating in industry.

After a great deal of experimentation with the plating baths described in the Bureau of Standards publications[1] and many possible variations thereof, we discovered that concentrations of solution components and strict control of initial pH were critical in the acid baths insofar as plating rate and quality were concerned. As disclosed in our U.S. Patent No. 2,658,841,[9] there is an optimum range of ratios of nickel ions to hypophosphite ions at an optimum absolute hypophosphite concentration.

If the nickel-to-hypophosphite ratio is below 0.25, the plate has a dull gray, nonmetallic appearance. If this ratio is above 0.6 the rate of deposition becomes very

Table I — Bureau of Standards Acid Plating Baths

	1	2	3
Nickel chloride, $NiCl_2 \cdot 6H_2O$	30	30	30
Sodium hypophosphite, $Na(H_2PO_2) \cdot H_2O$	10	10	10
Sodium hydroxy-acetate, $NaC_2H_3O_3$	50	10	—
Sodium citrate, $Na_3C_6H_5O_7 \cdot 5\frac{1}{2}H_2O$	—	—	10
Rate of deposition (in. per hr.)	0.0006	0.0005	0.0002

pH for all three baths is 4 to 6, and temperature of plating is slightly below boiling point.

poor. A high concentration of hypophosphite ions results in instability, while a low anion concentration again slows deposition. Other factors of lesser importance also influence the quality of these deposits.

It should be pointed out that the preferred conditions are always a function of the quality of the bath. Using sodium acetate as a buffer, an alkali hypophosphite and nickel chloride, best results are obtained with baths to these limits:

Ratio of nickel to hypophosphite ions	0.25 to 0.60 mol
Hypophosphite concentration	0.15 to 0.35 mol
Initial pH	
Na^{++}	4.6 to 5.5
Ca^{++}	5.0
Buffer concentration	0.120 mol
Ratio of solution volume to catalytic area	10

Even under these optimum conditions, the plating rate is too slow and will not meet the minimum requirements of industry. It was discovered that the addition of certain organic anions (for example, unsubstituted short-chain aliphatic dicarboxylic acids[10] will substantially raise the speed of deposition up to values of 1.5 mils per hr.—an increase of 3 to 5 times over those obtained by Brenner and Riddell. In addition, bath stability in batch operation is enhanced. The effect of these reagents is to loosen the bond of the hydrogen atoms attached directly to the phosphorus atom in the hypophosphite molecule by complex formation.

As can be seen from equation 3, the hypophosphite anion consumed by the reaction is oxidized to phosphite ion. While nickel hypophosphite is very soluble, nickel phosphite is not. Accordingly, as plating proceeds and the concentration in phosphite increases to the critical threshold, a precipitate will form in the bath (Brenner's "basic salts"). This not only results in rough deposits, but the solid particles (even those of submicroscopic size) act as decomposition nuclei and random precipitation of metallic nickel occurs which, in turn, functions as a catalyst. Several additives were developed by our laboratories that retard considerably the precipitation of nickel phosphite without substantially impairing plating rate or quality (patent pending).

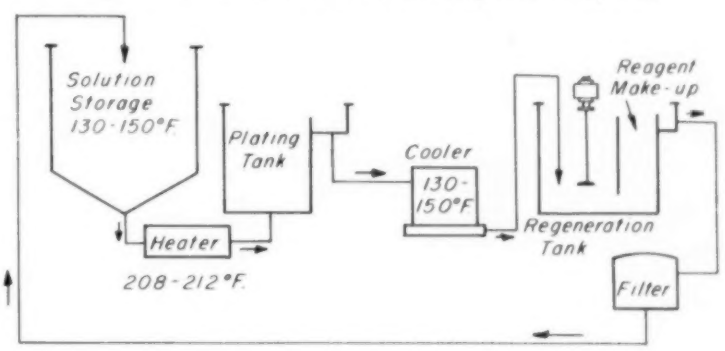
When plating is performed as a batch operation, whether discontinuous or semicontinuous, the deposit cannot be homogeneous in the vertical direction because composition of the bath is constantly changing through depletion of nickel and hypophosphite ions and through increased concentration of phosphite and hydrogen ions. As a matter of fact, the work of the National Bureau of Standards has shown that this coating has a stratified structure. It has been discovered that continuous circulation, filtration and regeneration are required to keep the bath composition substantially constant in production (U.S. Patent 2,658,839).[11]

Regeneration, or the continuous feeding of the necessary chemicals to the bath in amounts equal to those consumed by the plating reaction, can be automatically controlled by instrumental analysis of the variation of one single constituent, others being fed in fixed proportions. On the other hand, while it is desirable to add these chemicals as solutions of virtually saturated strength, this cannot be done when the bath is at elevated temperature. Local decomposition will then occur in zones of high concentration.

The plating system, incorporating the stated conditions, is as follows: The plating bath is stored at a maximum temperature of 150° F. in a reservoir of sufficient capacity (see Fig. 1), from where it flows into the plating tank through a heat exchanger which raises its temperature to between 208 and 212° F. From the plating tank it goes through a cooler, bringing it back to below 150° F., then into a regeneration vessel where reagents are added in automatically controlled amounts so as to bring the solution's components to their original concentration. The liquor then runs into a filter. Finally, the bath is returned to the storage reservoir.

The cooling and heating are performed in an

Fig. 1 — Schematic Diagram of Equipment for Maintaining Continuous Circulation, Filtration and Regeneration of Bath



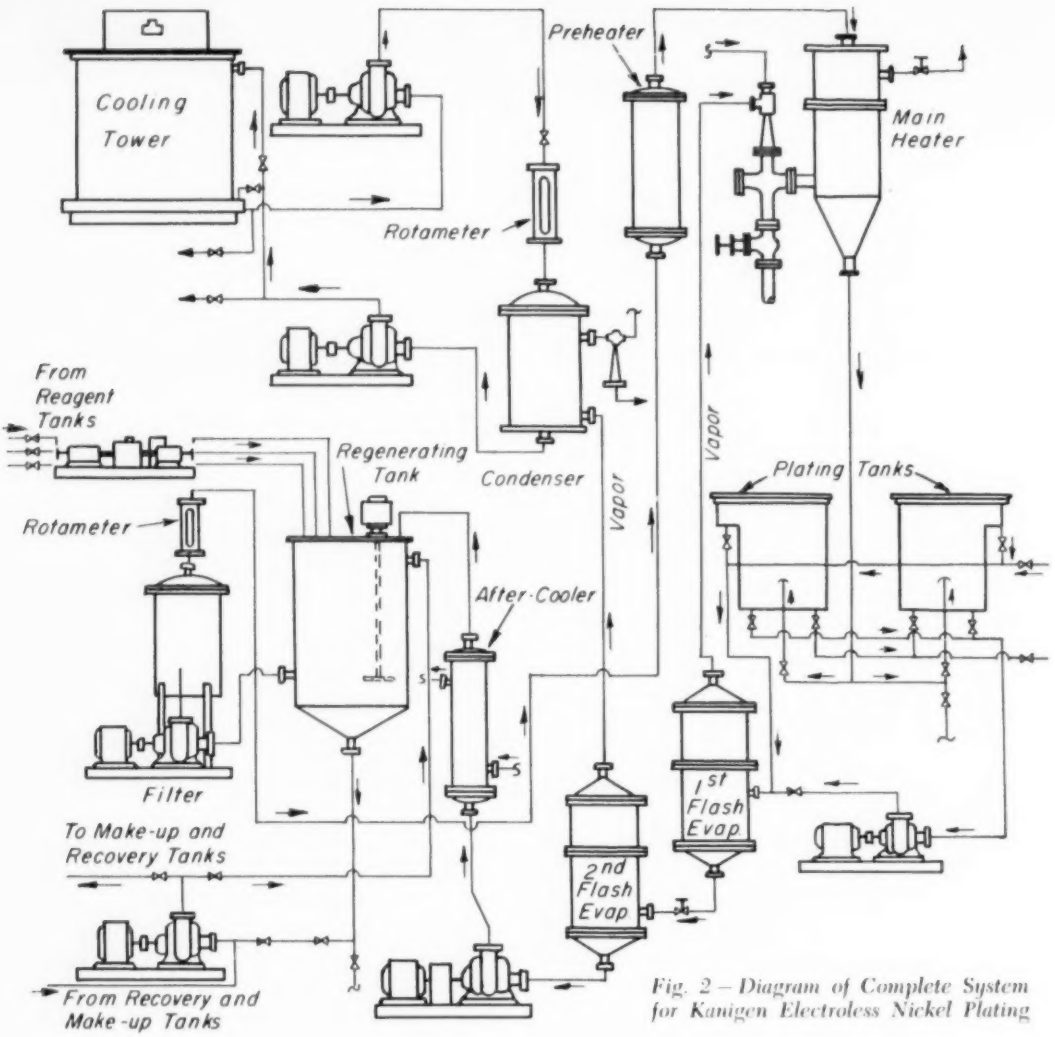


Fig. 2 – Diagram of Complete System for Kanigen Electroless Nickel Plating

original and most efficient manner (patent pending). To decrease the temperature, the necessary amount of solvent (water) is flash-evaporated by vacuum. This results in concentration of the solution. Heating is accomplished by injecting steam in such a manner that the dilution due to the condensate produced will balance exactly the loss caused by flash-cooling (Fig. 2).

When operating as described above, plating bath composition stays constant and, therefore, the deposit has a maximum of homogeneity and is bright, dense, and free from pores.

It was found that the continuous heating-cooling cycle is likely to cause thermal decomposition. In other words, the plating solution, after a certain number of cycles, becomes relatively unstable. This led to the development of specific stabilizers, some of which, in addition to their principal function, favorably influence deposition rate and coating appearance.

To summarize, the Kanigen bath contains essentially nickel cations, hypophosphite anions, plating-rate "boosters", phosphite precipitation controllers, and stabilizers. The Kanigen process gives a stable, brilliantly clear bath of constant composition throughout the plating operation.

The necessary chemical control methods employ simple, photocolorimetric procedures that can be used by any laboratory technician.

Composition and Properties—The principal properties of Kanigen plating may be summarized as follows:

Chemical composition (average) – 7% phosphorus, 92% nickel.

Structure – Probably amorphous.

Hardness (as deposited) – Vickers 500 (about Rockwell C-49)

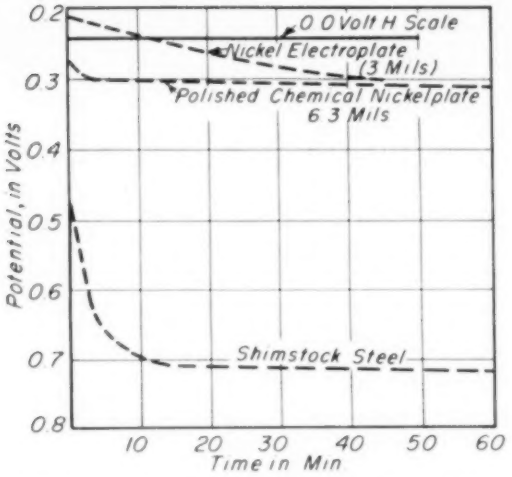


Fig. 3 – Comparison of Potential for Nickel Plate With Kanigen (Reference to Calomel Electrode)

Corrosion resistance – At least equal to and generally better than wrought nickel.

Coefficient of expansion – 13×10^{-6} in. per in. per ° C. or 7.22×10^{-6} in. per in. per ° F.

Electrical resistivity – Approximately 60 microohms per cm.

Adherence – Excellent on steel and copper alloys; good on ferrous alloys, aluminum, and on thermosetting plastics.

Porosity (as deposited) – No porosity for minimum thickness of 0.2 mil.

Melting point – Between 2000 and 2190° F.

With the standard acid solutions, the coating averages 7% phosphorus. It is highly probable that the phosphorus is present as a solid solution in nickel, and that the deposit is amorphous (as shown by chemical tests and X-ray diffraction).

By heat treating at 750 to 930° F. for 1 hr. in a reducing or inert atmosphere, the hardness can be raised to from Vickers 500 or 600 to 900 (Rockwell C-64). A heat treatment at about 1110° F. for 1½ hr. results in a hardness at room temperature of Vickers 700, but the ductility is increased, so that wear resistance is improved.

Heat treatment at about 1470° F. for 1 hr. will produce a room-temperature hardness equal or below the original value, depending on the kind of plating bath used. Thus, one kind of coating will have a hardness of Vickers 250 after 1 hr., with good ductility permitting considerable bending without stress failure. The hot hardness of Kanigen above 750° F. (that is, the hardness at elevated temperature) is low, and coated parts are unsuitable for applications above this temperature, particularly where abrasion is involved. The hardness of the coating usually gives good abrasion resistance, particularly if properly lubricated. The "Taber" index is 13.7 for a standard Kanigen coating.

Corrosion resistance of Kanigen plate is at least equal to and generally better than that of pure nickel. This is due to the phosphorus content of the deposit. See the curves plotted for time versus potential (Fig. 3), which reveal that Kanigen is more "noble" than nickel electroplate. The amorphous character of these coatings (which do not show a crystalline structure in X-ray diffraction studies) also may account for their higher corrosion resistance. Some test results are reported here.

Samples of 20 sq.cm. were compared with pure nickel in a 75% caustic soda solution at 240° F. After 21 days, the weight loss was 0.5 g. for pure nickel and from 0.05 to 0.09 g. for Kanigen.

Corrosion rate in fluorophosphoric acid was 0.00156 in. per year.

Samples plated with Kanigen showed no attack after immersion for 21 days in the following aerated liquids at about 120° F.: sour crude oil, petroleum white oil, odorless naphtha, acetylene bromide, photographic developer, and photographic fixing solution.

The salt spray resistance of this coating submitted to the standard test (A.S.T.M. Specification B117-49T) is very good. With a 1-mil coating on cold rolled mild steel coupons (¼x1½x6 in.), the average time to failure is 96 to 120 hr., the minimum is 72 hr., while the maximum is over 2000 hr.

If a soft copper coating 0.3 mil thick is plated over the steel, buffed, and then Kanigen is deposited over it, the salt spray resistance is:

Kanigen Thickness	Time to Failure Min.	Max.
0.1 mil	24 hr.	48 hr.
0.2	92	113

While salt spray tests are an accepted standard procedure, generally prescribed in many government and industrial specifications, the consensus denies any absolute value to the results established by that method. Not only are the data thus obtained inconsistent, but often contradictory, and can never be related to actual usage. Nevertheless, through lack of any better test, the brine fog cabinet is still a standard tool.

Our research work has established by circumstantial evidence that, in the case of thoroughly cleaned and Kanigen-plated mild steel, a close relationship exists between surface inhomogeneity of the base metal and the salt spray resistance of the overlaid plating. These inhomogeneities on the base metal surface are

probably caused by local variations in Kanigen composition (possibly phosphorus content), which, in the presence of a corrosive electrolyte such as brine, create galvanic action and induce porosity. For that very reason, a thin undercoating of copper on mild steel gives amazingly high resistance to salt spray. Of course, any accidental local impurity on the base metal surface, such as smudges, grease film and oxide layers, will impair adherence as well as salt spray resistance.

When our pilot plant, after a few short experimental runs, went into production in late 1952 excellent salt spray resistance was obtained. Then, in the summer of 1953, the results were highly disappointing. Average time to failure for a 1-mil coating was about 16 hr., while the minimum was frequently less than 4 hr. The same condition prevailed in the new large plant through August, September and October. Work was started in the laboratory to study the causes for this setback. After numerous failures, a pretreatment cycle was finally developed that gave very good salt spray resistance (average time to failure 98 to 120 hr. and a minimum time of 72 hr. for a 1-mil coating) even under adverse conditions. Finally, during 1953, salt spray results for coatings made without the new pretreatment again became excellent. The evidence strongly indicated that the plant water was the culprit, or, more specifically, the seasonal variations in water pollutants. In order to make our operations independent of Lake Michigan as a supply, drilling of a deep well was started. Today, we can definitely state that the average salt-spray resistance of Kanigen is at least twice that of electrolytic nickel plate.

Fig. 4 – Micrograph of Razor Blade Tip Plated With Kanigen Shows Uniformity of Coating. 250×



Another important characteristic of these coatings is that whenever rust spots appear as a result of salt spray testing, they do not spread upon continued exposure to the brine fog—contrary to what is always observed with electrolytic nickel coatings. This fact represents one of the biggest advantages of Kanigen, and actually makes A.S.T.M. Specification B117-49T—written for the appraisal of electroplating—entirely unsuitable and obsolete for chemical nickel deposits. Our work has constantly shown that, following the appearance of a few rust spots after about 200 hr. in the brine-fog cabinet, the plated steel samples could remain without further change in the brine spray for at least 700 and up to 2000 hr. While, according to the specification, the appearance of 6 rust spots per sq. ft. represents "failure" of the coating, this is actually not true for Kanigen. Electroplated deposits, on the other hand, will start disintegrating rapidly as soon as a small number of pores allows oxidation of the base metal. No common yardstick, therefore, should be used to compare the resistance of electrolytic nickel and electroless nickel to chemical attack. While the A.S.T.M. salt spray test could be used, a change in the evaluation appears to be necessary for chemical platings. A more quantitative method is being devised and will be proposed for adoption by that group.

The adhesion of Kanigen deposits to low-carbon steel, to copper alloys and to nickel can be termed excellent. No flaking occurs from a 180° bend over a 2-in. diameter mandrel. Upon reverse bending to 180° some crushing and slight powdering occurs in the compression zone, particularly when the deposits are thicker than 2 mils, this being on account of the hardness of the coating. A direct bend to 180° over a 3-in. mandrel, followed by a 180° reverse bend, shows no flaking or cracking visible to the naked eye. It has been proved that, as long as the basis metal is not permanently deformed, excellent protec-

tion is afforded by these coatings. The plating shows no failure in tensile tests prior to the point at which the basis metal exceeds its elastic limit and breaks. No peeling occurs at a distance greater than 1/16 in. from the break.

The adhesion of Kanigen deposits to aluminum, steel, and stainless steel alloys is good when specially developed pretreatment methods are applied. This is being constantly improved. Adhesion to thermosetting plastics, ceramics and glass varies from good to fair, depending on the type of base material. Adherence to these is mechanical rather than physico-chemical.

Kanigen deposits, when plated on a metal of reasonably good quality, are nonporous at thicknesses of 0.2 mil and more. This has been proved by four experimental methods:

1. Results of standard production tests, which consist of immersing the plated parts in hot (180 to 185° F.) aerated water for 30 to 60 min., have constantly been negative.

2. A modified ferroxyl test produces no pores on plated samples for thicknesses above 0.1 mil.

3. Gaseous diffusion tests revealed total lack of porosity on a 0.25-mil coating of Kanigen.

4. A thin coating of aged (decayed) radioactive iron isotope, emitting only soft X-rays which are effectively shielded by nickel, was electroplated on mild steel disks. Kanigen was deposited over the iron isotope in thicknesses of 0.2, 0.4 and 0.6 mil, and photosensitive plates were exposed to these, as well as to radioactive disks covered with identical thicknesses of electroplated nickel. Radiographs for the latter showed a considerable number of black spots, whereas those for the corresponding Kanigen-coated disks gave pictures without a single blemish.

Physical Character of Coatings

The uniformity of the thickness can be kept within less than 10%; for example, for a specified thickness of 0.001 in., the extreme variations would be 0.0009 to 0.0011 in. With care, even closer tolerances can be obtained (Fig. 4).

Although in continuous operation the coating can be deposited to any desired thickness, it is impractical to exceed 6 to 7 mils, particularly for a plant on a one-shift schedule. Actually, full protection is afforded by 0.5 to 1 mil in a noncorrosive medium (corrosiveness being here taken as related to Kanigen). In mildly corrosive service, a thickness of 5 mils is generally sufficient to resist liquids or gases for which electroless nickel plating is considered suitable.

These coatings reproduce the character of the underlying surface with a slight smoothing effect. A highly polished part, after plating, will have a mirror-like appearance without additional buffing, while a rough casting will be just as rough when removed from the bath. The "color" of the coating is a metallic light gray with a slight yellow tinge. A special additive produces a white color without increasing the optical coefficient of reflection.

An after-treatment has been developed to blacken the Kanigen surface. It is interesting to note that pure nickel does not respond to the same process. In a corrosive atmosphere, ordinary Kanigen will slowly tarnish (as does pure nickel) without losing any of its physical qualities. As a matter of fact, its chemical resistance appears to increase through "aging".

Principal Applications

The infinite "throwing power" of this process and the attendant uniformity of deposit and its protective qualities make it ideally suitable for use on irregular or complicated shapes of ferrous alloys, copper, brass, bronze, and aluminum which are difficult or impossible to plate by conventional methods. This use is particularly advantageous with items such as unusually large pieces or tanks; complex fabricated assemblies; forgings and castings; parts having screw threads, indentations, or holes which must be uniformly coated with a protective deposit; and the interiors of vessels, tubes and pipes. The coating offers possibilities as an economical alternate for nickel and some of the special alloys used in assemblies which must be corrosion resistant, since the Kanigen lining can be deposited over an inexpensive basis such as mild steel or brass.

Plating of Kanigen on nickel (whether electrolytically deposited or otherwise), on nickel alloys and on itself is easy. Plating on sintered metal shapes gives excellent results, with no peeling or bleeding occurring in storage or use.

The coating cannot be applied on lead, cadmium, zinc, tin and antimony, nor on surfaces that have been contaminated with them (as on cadmium plate and galvanize). This precludes chemical plating on parts soldered or brazed with tin or lead alloys. On the other hand, some alloys in which these metals are used in small proportions, such as certain bronzes, plate satisfactorily.

Adhesion on stainless steels, molybdenum and other alloy steels is variable. Generally, a special treatment is required to obtain best results. Good adherence is difficult or impossible to obtain on casting alloys of aluminum and steel which con-

tain a high percentage of silicon. Chemical plating on zinc die castings is best performed over a thin electroplate of copper. This will impart better adhesion and durability of the final plate. Direct chemical plating on magnesium is still in the development stage.

In view of the uniformity and the lack of porosity of deposits, no allowance has to be made for depressions, and no large safety factor is required. If the specification calls for 3 mils deposit, a factor of plus 10% is sufficient. This allows large savings in nickel, and, consequently, in plating costs. The high uniformity of the plate gives the planning engineer greater freedom in designing parts for best application and most economical fabrication. The only precaution to be observed in design is to avoid pockets where the hydrogen evolved in the process could be trapped to prevent plating.

The coatings can be soldered with ease, provided the temperature is sufficient for obtaining flow. Rosin-core solder provides excellent adhesion. For ordinary solder, the recommended flux is 40 parts of saturated solution of rosin in methyl alcohol and 1 part 85% phosphoric acid. Although Kanigen-plated pieces can be arc welded with an inert-gas-shielded pure nickel rod, there is generally enough phosphorus pick-up to result in a brittle bond. It is therefore advisable to perform all welding before plating.

An interesting special application of the Kanigen process is to make aluminum solderable. A very thin coating about 0.00005 in. obtained by a quick dip is sufficient for this purpose. Aluminum can also be tinned after it receives this pretreatment. Copper, gold, chromium and other metals can be plated over Kanigen coatings by using standard methods.

Plating on Nonmetals—In order to deposit Kanigen on materials such as thermosetting plastics, ceramics and glass, a particular pretreatment is required (patent pending). The resulting bond is mostly mechanical (except in specially formulated plastics), and therefore relatively weaker than with metals.

In view of the temperatures at which the bath is operated, plastic materials with a low softening point are not suitable for plating. Even the heat resisting thermosetting materials such as the bakelites sometimes contain fillers which have high absorption for water, and, therefore, will show an "orange peel" effect on the surface of the coating. Mineral-filled phenolics generally take excellent plating, with good adhesion and no flaking even upon breaking the part.

Porcelain, stoneware, and similar ceramics can be coated with an adherent deposit, provided they are not glazed. Glass has to be frosted mechanically or chemically before plating. The resulting deposit is dull and not suitable for optical purposes unless it is polished. The adherence to glass is only fair. Most uses of the plate on nonmetals should be directed toward obtaining a seal or a solderable surface, a base for electroplating a more conductive coat, a moisture barrier, or a hard, abrasion resistant surface.

Economic Considerations

The cost of Kanigen processing for industrial purposes can be compared only rarely with that of electroplating. Many of the applications calling for General American's electroless coating are simply out of the question with electroplating. When substitution is possible, electroplating is, at this time, somewhat cheaper; but, on the basis of the uniformity and nonporosity of Kanigen, substantial savings are possible by lowering the safety factor to 10% and using the thinnest coating that will still give full protection.

In the decorative field, electroplating is generally less expensive, unless the design of the part precludes the use of electrodes. Generally speaking, this electroless plating method is competitive with electroplating whenever the latter is applicable, although technical considerations (such as higher corrosion resistance, greater hardness, and others) might be in favor of the electroless coatings. In a number of instances, electroplating cannot be used at all, as for fabricated equipment such as screw conveyer sections, or for intricate shapes such as valves, complex housings, gears, and screw assemblies.

The electroless plating process developed by General American Transportation Corp. offers the processing, mechanical, and electronic industries a standard material of construction with new surface properties—namely high corrosion resistance and superior hardness. Possible applications for Kanigen are so numerous that they cannot be described within the frame of a magazine article. Any engineer blessed with imagination will find in his own field many possibilities that would make items with this coating preferable to that currently being used. Of course, it is necessary to evaluate each application as a separate problem, and to weigh carefully advantages against cost, preferably in a discussion with men who are familiar with the technique and possibilities of electroless plating operation.

Here's a New, Easy Way to ADD VANADIUM TO STEEL

NEW . . .

ELECTROMET ferrovanadium now comes packed in bags. This makes it easy to charge to the furnace or add to the ladle.

NO WEIGHING . . .

Each bag holds exactly 25 lb. of contained vanadium. Just count the bags. Weighing is not necessary.

EASY TO IDENTIFY . . .

Bags have wide blue bands for positive identification. Dirt is kept out and there is no chance of mixing with other alloys.

LOWER HANDLING COSTS . . .

You can get pallet shipments at no extra charge. Pallets are easy to handle by lift truck or crane — and they need not be returned.

HIGH-QUALITY ALLOYS . . .

ELECTROMET ferrovanadium is uniform in analysis, closely graded, correctly sized, and physically clean. There are four grades — high-speed, special, open-hearth, and foundry.

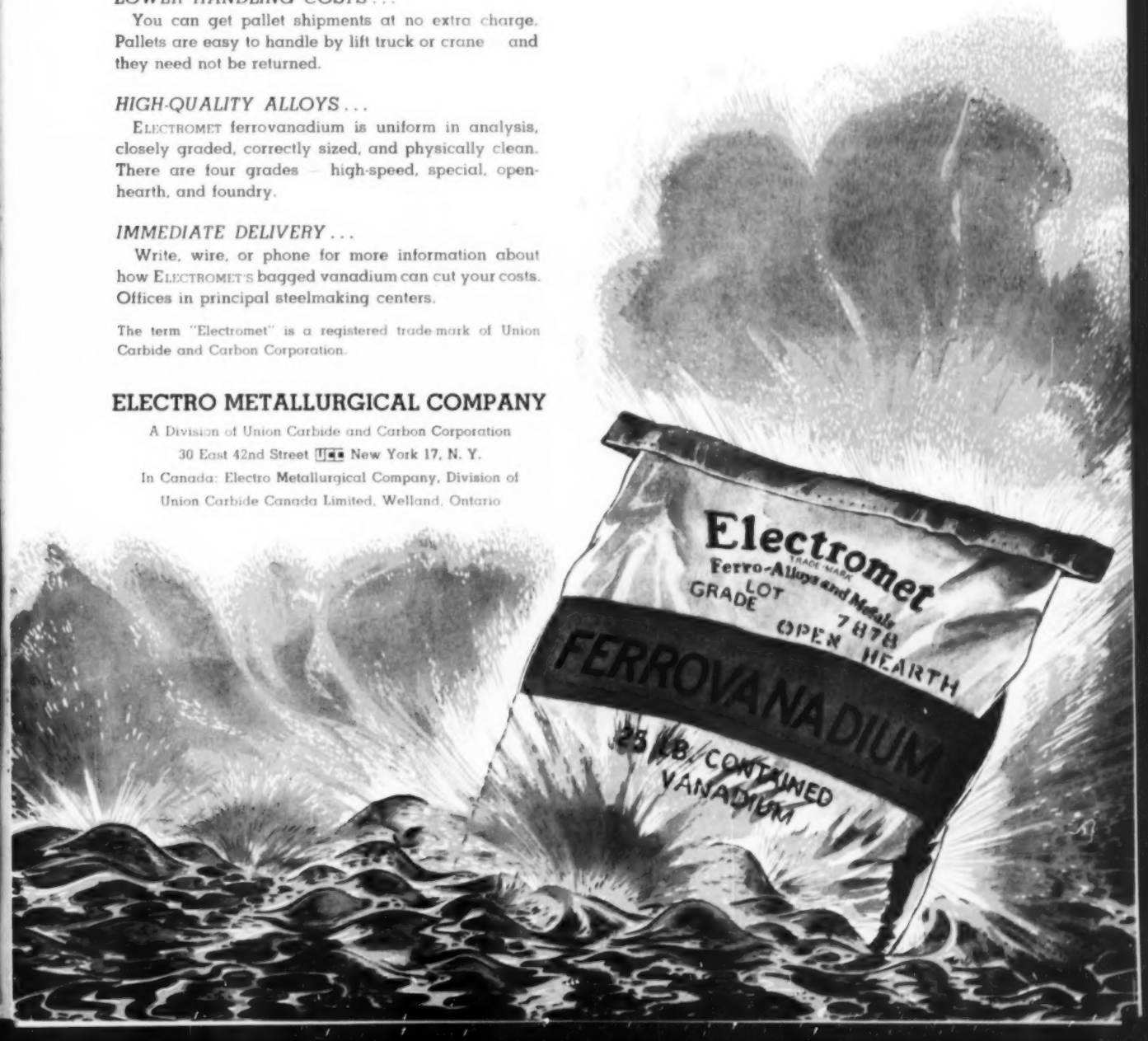
IMMEDIATE DELIVERY . . .

Write, wire, or phone for more information about how ELECTROMET'S bagged vanadium can cut your costs. Offices in principal steelmaking centers.

The term "Electromet" is a registered trade-mark of Union Carbide and Carbon Corporation.

ELECTRO METALLURGICAL COMPANY

A Division of Union Carbide and Carbon Corporation
30 East 42nd Street New York 17, N. Y.
In Canada: Electro Metallurgical Company, Division of Union Carbide Canada Limited, Welland, Ontario



Correspondence

Aircraft Engine Valves, 1917

SHEFFIELD, ENGLAND

The March issue of *Metal Progress* (p. 109) carries a brief note concerning some ½-ton ingots of stainless steel furnished Daniel Doncaster and Sons, January 1917, by Stavanger Electro-Staalverk, A/S of Norway. Our old records have been searched and the first mention of Stavanger stainless steel is dated October 1917 when tests were made as follows:

	2071*	2290	S.19
Elastic limit	69,000	93,500	93,500
Max. stress	129,000	114,000	114,000
Elongation in 2 in.	17.0	24.0	25.0
Reduction of area	27.5	60.3	63.6
Izod impact	77	—	—

*Air cooled from 1560, tempered at 1290° F.

2071 and 2290 may be either Stavanger cast numbers or our own test numbers. S.19 represents a specification for aircraft poppet valves. While we are now the second largest makers of poppet valves in England, at that time we were making very few, and we sold this 1917 steel (3-in. square billets) to Hughes Johnson's Stamping Co., Ltd., Langley, Birmingham, who forged it into poppet valves.

While these records show an early production of medium-carbon chromium steel of cutlery type, they do not indicate that the low-carbon stainless steel of about 12% Cr was made prior to the June 1920 date quoted by Monypenny.

BASIL W. DONCASTER
Chairman
Daniel Doncaster & Sons, Ltd.

Australia's Memorial to U.S.A.

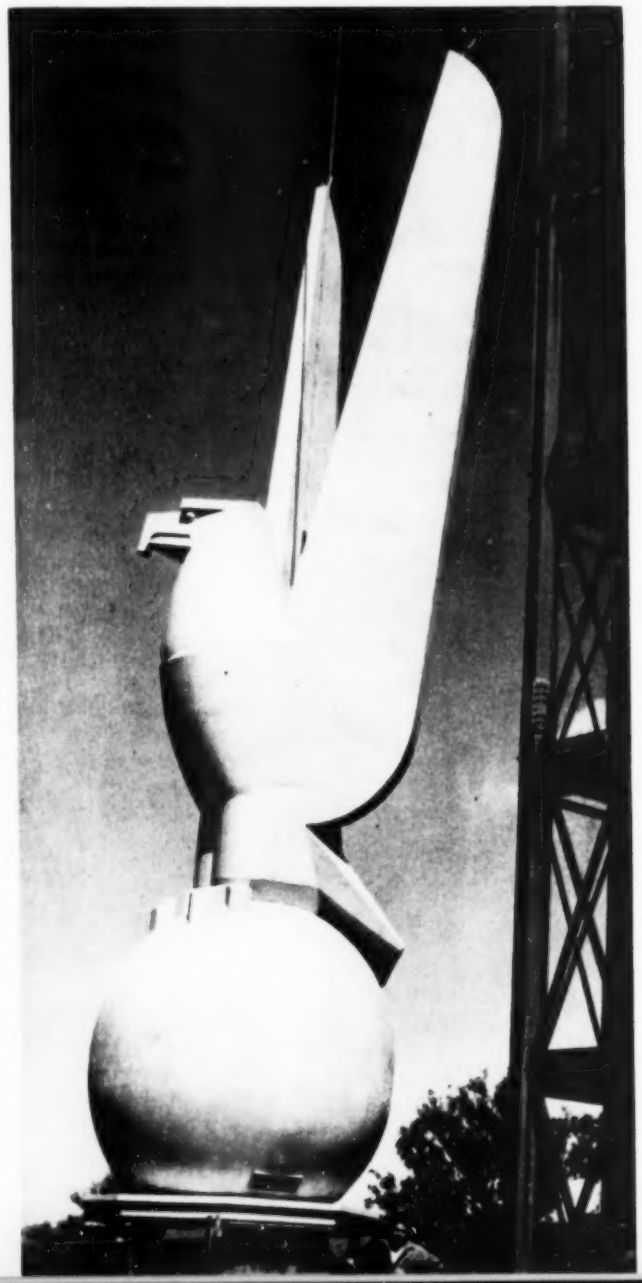
SURREY, ENGLAND

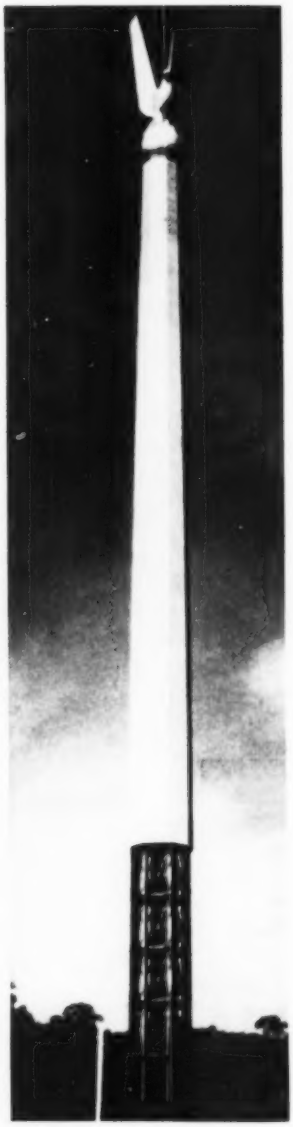
Australia's National Memorial to the United States of America, which Her Majesty Queen Elizabeth II unveiled in the federal capital Canberra on Feb. 16, is sheathed with aluminum. Erected as a tribute to the people of the United States by the people of Australia, it commemorates the great contribution made by the American armed forces to victory in the Pacific.

The memorial, to which the public subscribed $142,000 and the Commonwealth government donated $113,000, takes the form of an octagonal aluminum-covered shaft, 258 ft. high, surmounted by an aluminum sphere on which stands an American eagle, also wrought in aluminum.

The Shaft

The framework of the shaft, incorporating a stairway to the top, uses some 80 tons of steel. It is covered with Noral 2S½H alloy sheets, 3/16 in. thick, 10 ft. high and the full width of the





Photograph on P. 122 Shows Aluminum Sphere and Eagle Ready for Hoisting Into Position Atop Australia's National Memorial to America. Note man's head at base of photo. Directly alongside is the shaft in course of erection, with aluminum paneling partly completed

face. This alloy is 99% pure aluminum, half-hard, with an ultimate tensile strength in the region of 15,700 to 19,000 psi. The sheets were rolled at Northern Aluminum Co.'s works in England to a high degree of flatness to insure the memorial's good appearance. The sheets, which have a sand-blasted finish, are folded 3 in. from each edge to give them a tile appearance and extra stiffness, and the edge fold at the top of each sheet and at one side is given an additional fold in the reverse direction to provide a weather lap between the sheets. Each sheet is also stiffened transversely by three folded channels of the same material; these are equally spaced on the back of the sheet and fixed by welding and by countersunk ⅜-in. aluminum bolts, plain headed, ground flush.

The sheets are fixed to the shaft at the bottom edge only, where aluminum angle cleats are bolted onto them, these being bolted to steel cleats on the columns; the top of each sheet is bolted to the sheet above, and the side of each sheet is bolted to the sheet adjacent. Steel spring washers (which are plated with cadmium) on the fixing bolts provide a ¼-in. space between mating surfaces of the sheets, to accommodate expansion or contraction. Aluminum bolts ½ in. in diameter are used, with castellated nuts and cotter pins for locking. Where aluminum cleats and bolts connect to the steelwork, they are insulated with polythene washers and ferrules to prevent galvanic corrosion. The sheets were bolted together in sets of four at ground level and hoisted into position, guided up the outside of the shaft by two vertical tensioned wires.

The Sphere and Eagle

The top of the shaft is capped with folded and welded aluminum strip on which stand the sphere and eagle fabricated as a single unit. They were panel-beaten from alloy sheet of similar composition and strength to that used for the shaft, but manufactured by Australian Aluminum Co., Pty. Ltd. The sphere, which is 10 ft. high, has a 9-in. flat circumferential section, making it slightly higher than it is wide, thus giving the effect of being a perfect sphere when viewed from the ground. The eagle, its wings outstretched, is 28 ft. high.

The sphere and eagle were constructed around a short steel tower, that was later bolted to the top of the main shaft. This tower supports the eagle's body and its wings, the latter by means of two 8-in. steel tubes, reduced to 3 in. at their extremities, which are fastened to the tower. The panel-beaten sheets were welded together by "Argonarc" process without flux, thus avoiding a possible source of corrosion. The sheet for the wings was plug-welded to aluminum diaphragms placed at 3-ft. centers and bolted to the supporting steel tubes. All attachments of aluminum to steel were made with ½-in. aluminum bolts insulated to prevent galvanic action. The whole surface of the emblem was ground smooth with a disk sander and given a matte appearance by sand-blasting before hoisting into position.

Design

Architect for the memorial was Richard M. Ure, principal architect of the Department of Works, Canberra; sphere and eagle were designed by Paul Beadle, Newcastle, N.S.W., who built from timber battens a full-size model which was used in fabricating the aluminum replica. Consulting engineers Crooks and Michell, Sydney, designed the structural steelwork and concrete foundations; and the contractors were McConnell Building Co. Pty. Ltd., Sydney.

TOM BISHOP

(More correspondence on next page)

Wartime Work on Bazooka Rockets

NEW YORK CITY

Perhaps it is not too late to send a note to the "Department for Amplification of the Record" about a statement made in the October 1953 issue of *Metal Progress*, page 84, which refers to the wartime development of the bazooka rocket and credit therefor.

At the time General Eisenhower started his North African campaign his troops discovered that the bazooka rocket, then newly supplied by the Ordnance Department, was frequently more dangerous to the man firing it than to the enemy tank. The motor tube was made of low-grade, low-carbon steel tubing. It was not heat treated and possessed an extremely low hoop strength. A further point of weakness was the silver brazed joint between the fuse body and the war head containing the explosive.

I was in the Rocket Division of the Ammunition Branch in the Pentagon at the time (and also a member of the rocket development group of the National Defense Research Committee) and secured a research development contract for the A. F. Holden Co. to improve the bazooka rocket motor tube. My subsequent hydraulic tests at Yale University showed that seldom was the brazing more than 25% effective, due to poor fit and dirt in the joint, while the use of uncontrolled induction heating destroyed what few physical properties the tube itself had. As a result, most of the motor tubes blew up at about 6000 psi. pressure.

We produced results in six weeks; the cost was $9,000. The answer was the use of seamless S.A.E. 8630 or 8640 steels, salt bath copper brazing, stabilizing at above the upper critical point and austempering. All the heat treatment was done in salt baths. Average bursting pressure was raised to 40,000 psi. (The Ordnance Department required only 19,000 to 20,000 psi. pressure with heaviest propellant charges.)

Thus, I believe that the real credit for this development in bazooka and rocket manufacture rests not with any one of several furnace makers who furnished salt baths in wartime production but to the contractor, A. F. Holden Co., and to the National Defense Research Committee. Individuals who are responsible for the simple underlying ideas were Mr. Holden, the late T. A. Atkinson of the Rocket Division, Charles Hammond, formerly of the Holden Co., and myself. The coordinating engineer for the National Defense Research Committee was Edmund Wagner.

GEORGE N. VITT
Editor
American Exporter Industrial

Arc Welding of Nodular Irons

NEW YORK CITY

An article entitled "Metallurgical Impasse in Welding Nodular Irons" appears on p. 174 of the February 1954 issue of *Metal Progress*, as a digest of the American Welding Society paper, "Welding Metallurgy of Nodular Cast Iron", by Edward E. Hucke and Harry Udin. This digest is based entirely upon the preprinted paper, which was published in the *Welding Research Supplement* for August 1953, and therefore does not include any of the highly significant discussion at the fall meeting of American Welding Society in Cleveland in October, 1953.

As a result one gets the impression that nodular irons are not weldable when, in fact, they have been successfully welded on a commercial scale for several years. The nickel-iron cored electrode regularly employed by industry was not investigated by Hucke and Udin. Moreover, the abnormally high silicon contents of their ductile iron would also encourage brittle welds with *any* type of electrode.

From the previously mentioned discussion by T. E. Kihlgren and from the paper, "Joining of Ductile Iron by Several Arc Welding Methods", by the same author and H. C. Waugh, presented at the spring meeting of American Welding Society in Houston, Tex., in June of 1953, it is apparent that ductile iron *is* weldable using a variety of techniques. Actual joint-strengths closely approximate those of the base metal. [See p. 150 for a summary of these studies.]

The very title of the Hucke-Udin digest, "Metallurgical Impasse", etc., implies that the welding of ductile iron constitutes a problem which is incapable of solution.* Since this is certainly not true, we hope that steps will be taken to set the record straight.

C. L. HOOBLER
Development and Research Division
International Nickel Co., Inc.

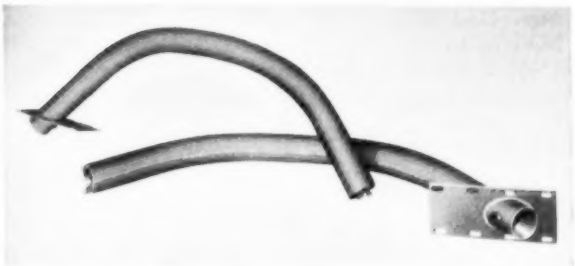
*EDITOR'S FOOTNOTE—One definition of "impasse", from Funk & Wagnalls' New Desk Standard Dictionary is "Any serious . . . obstacle or problem".



The THIN DENSE WALLS of 'PSC' RADIANT TUBES



step up furnace efficiency



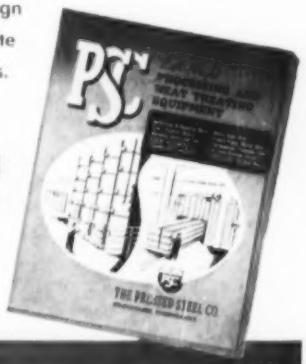
These tubes will help you get more production from your furnaces because: (1) Their light-wall construction saves both furnace time and fuel. (2) Their uniform wall thickness and smooth interiors promote uniform flow of gas. (3) Their dense walls all but eliminate the problems of porosity, carbon build-up and consequent burning-out. And, being 33 to 50% lighter than cast tubes, PSC fabricated alloy tubes cut initial cost and are easier to handle. A feature of PSC radiant tubes are their return bends, which are fabricated to give uniform wall thickness throughout. Tubes in any design or dimension. Write us to your needs.

Parabolic Tubes Now Made by PSC to Your Order

PSC now furnishes all types of radiant tubes, including parabolics. The tubes are precision-assembled in the most complicated designs, in any desired wall thickness, and for any temperature requirements.

In addition to such furnace parts as internal and external tubing, retorts and covers, PSC manufactures annealing and carburizing boxes, baskets, trays, fixtures, etc., for every heat-treating purpose, and in any size and design.

Send for
HEAT TREATING Equipm't Cat'g 54

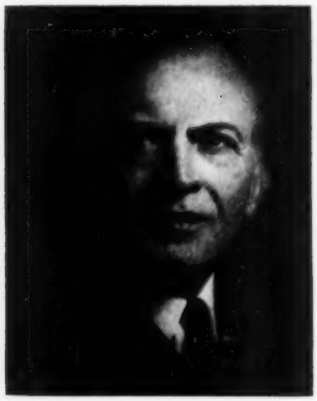


THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

Personal Mention



Edgar C. Bain

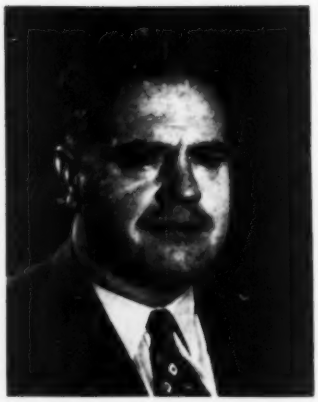
EDGAR C. BAIN, past president of the American Society for Metals, was recently elected a member of the National Academy of Sciences, bringing to four the number of ASMembers who represent the field of metallurgy in the Academy. **Albert M. Portevin**, consulting engineer of Paris, France, was one of three foreign associates elected at the same meeting. Other ASMembers belonging to the Academy are **Robert F. Mehl,** head of the department of metallurgy at Carnegie Institute of Technology, and **Zay Jeffries,** another past president, who has been vice-chairman of the Minerals and Metals Advisory Board of N.R.C. since 1951.

Dr. Bain is a graduate of Ohio State University (B. Sc., M. Sc., and honorary D. Sc.) and Lehigh University (D. Eng.). He is vice-president of research and technology, U. S. Steel Corp., where he has been since 1928. Details of his accomplishments there and earlier when he was with General Electric Co., Atlas Steel Corp., and Union Carbide and Carbon Research Laboratories, are given in a biographical appreciation in *Metal Progress* for December 1936. He holds many awards for his achievements in engineering and metallurgy, including the Gold Medal, Howe Medal, and Sauveur Achievement Award.



Waldemar Naujoks

WALDEMAR NAUJOKS has been elected vice-president and general manager of Globe Forge, Inc., Syracuse, N.Y., which is the highest post to be held at this subsidiary of Barium Steel Corp., New York City. Mr. Naujoks became associated with Globe Forge after five years as special projects engineer at the Ladish Co., Cudahy, Wis. The preceding 20 years were with the Steel Improvement & Forge Co., Cleveland, where he was chief engineer for 12 years. His outstanding reputation in the forging industry was recognized when he served as section chief in the forgings and castings section of the Office of Price Stabilization from October 1952 to March 1953. Mr. Naujoks is the author of the "Forging Handbook" and of "Fundamentals in Forging Practice." He also furnished forging data for the Metals Handbook, Kent's Engineering Handbook, and the Tool Engineers Handbook. He is a graduate of the University of Wisconsin with degrees in engineering and metallurgy, and is a registered professional engineer in the states of Wisconsin and Ohio. A past chairman of the Cleveland Chapter, Mr. Naujoks is also an active member of the American Society of Mechanical Engineers, American Society of Tool Engineers, and American Ordnance Assoc.



Ralph E. VanDeventer

Recently appointed chief metallurgist of Alloy Engineering and Casting Co. (Alloy Casting Co. Division) of Champaign, Ill., engineers and producers of heat and corrosion resistant castings, is RALPH E. VANDEVENTER, widely known in the automotive field for his association with Packard Motor Car Co. in Detroit since 1931. A graduate of the University of Michigan (B. S. in chemical engineering), he immediately joined Packard as chemist successively becoming chief chemist, car and marine engine metallurgist and – since 1945 – chief metallurgist. During World War II he did important work on castings and forgings for the Rolls-Royce aircraft engine, the early jet engines, and the Packard Navy diesels. Since the war his responsibilities with Packard included materials engineering, technical control of processing, quality analysis and manufacturing research.

In the new position at Champaign, Mr. VanDeventer will actively direct metallurgical operations and he will also assume executive duties on two large projects for the Navy's Bureau of Aeronautics and the Air Force (Air Materiel Command). In the latter he will be assisted by Arthur Townhill, assistant project director, who brings with him 25 years of experience on aircraft and automobile components made by Thompson Products of Cleveland, the last ten being as chief engineer and manager of the light metals division operating a large foundry for aluminum and magnesium components made by die casting and in permanent molds.

(*Continued on p.* 128)



When steel is produced in an electric arc furnace it is highly desirable to stir the molten metal, to assure uniform heat and avoid stratification of the various alloy constituents. Manual and mechanical methods have been used, but the most modern method is electrical—induction stirring. This is accomplished by sending low-frequency two-phase currents through copper coils immediately under the furnace. The magnetic field thus produced stirs the melt most effectively. Stirring can be reversed, and the contents of the furnace made to flow toward either the slag door or the pouring lip.

Because of the heavy currents required, copper's high electrical conductivity makes it essential. Since the stirring coils are close to the furnace, they must be water cooled, distilled water being used in a closed system. Copper's high thermal conductivity is vital here. The basic copper for the stirrers made by Elliott Company, Ridgway, Pa. for Aros Electric, Inc., New York, is Revere rectangular tube, .945" x .750", .157" wall. Elliott and Revere technical personnel worked closely on the problem of specifications, arriving at joint agreements on tolerances and temper suitable for bending. These proved successful from the start, again showing the value of close collaboration between Revere and its customers . . . If you have a problem in connection with copper and its alloys, and aluminum alloys, consult Revere. See the nearest Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

Personals

(*Continued from p. 126*)

The governmental projects include a study of "castings potentials to aircraft" – that is, the design and pilot plant production of structural castings of either steel or aluminum capable of serving where intricate assemblages of machined forgings or sheet metal would conventionally be installed. Eventually a design manual for aircraft castings will also be produced. The staff includes about 40 stress analysts, casting specialists, metallurgists and draftsmen.

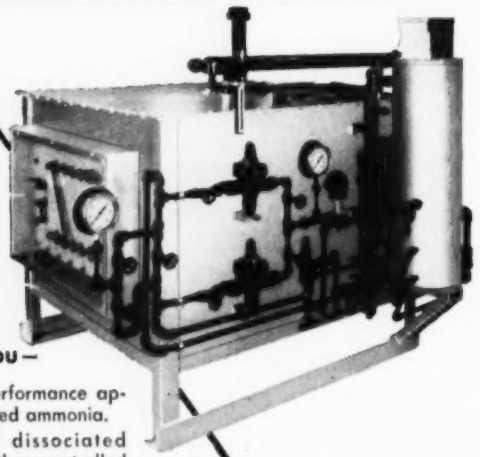
Robert A. Foley is now a salesman for Lindberg Engineering Co., Chicago. He was formerly district manager of the Chicago office for the Hevi Duty Electric Co.

William J. Ervin, Sr., formerly branch manager of the Indianapolis mill branch warehouse of the Carpenter Steel Co. of Reading, Pa., has been promoted to district manager of the Indianapolis territory and the southwest. **William J. Stephens** has been advanced from assistant manager to branch manager of Carpenter's St. Louis mill branch warehouse.

S&W AMMONIA DISSOCIATORS

with HORIZONTAL Cracking Chambers

are unconditionally guaranteed



Our Bulletin Tells You–

Cost-saving, better performance applications for dissociated ammonia.

10 advantages of dissociated ammonia over all other controlled atmospheres you have used.

S&W ammonia dissociating process, with schematic flow diagram of installation we recommend for you.

Specifications for standard S&W Dissociators with rated C.F.H. output from 75 to 2000. Larger capacities available on request.

S&W unconditional 6-month guarantee that your Dissociator will produce rated output and will be free from defects in workmanship and parts.

Get all facts about this efficient new-type equipment. Write today for your copy of Bulletin AD-1



S&W SARGEANT & WILBUR, INC.
186 Weeden Street, Pawtucket, R. I.

Electric and Fuel-Fired Furnaces • Atmosphere Generators • Gas Conditioning Equipment

Raymond B. Kropp, executive vice-president and treasurer of Kropp Forge Co., was recently elected chairman of the board and its chief executive officer, and as such will have complete control over the administration of manufacturing operations, inventories and schedules, as well as the power to administer all matters relating to finance. He will continue as treasurer of the company. Mr. Kropp is also president of the C. D. Gammon Co., Chicago.

George R. Foster has been appointed manager of the stainless steel division, general sales department, United States Steel Supply Co., division of the U. S. Steel Corp. He joined U. S. Steel in Pittsburgh in 1943, served in the Army in World War II, and transferred to the U. S. Steel Supply Co., Chicago, in 1947 as a salesman, where he remained until now.

James B. Hatch is now in the metal chemicals department of the industrial chemicals division of the American Cyanamid Co., New York. Mr. Hatch, who joined the company in April 1954 as a sales trainee, worked for Sylvania Electric Products, Inc., prior to joining Cyanamid. He is a graduate of the University of Illinois, receiving a B.S. degree in general engineering in 1943 and a B.S. degree in metallurgical engineering in 1953.

George G. Wilcox, formerly manager of the hand tool division of the New Britain Machine Co., New Britain, Conn., has been elected vice-president of the division.

M. G. Manker, who formerly served as district sales manager in the Syracuse, N. Y., area, is now Philadelphia district sales manager for Copperweld Steel Co., Warren, Ohio.

Edwin Y. Bready, formerly director of purchases of Standard Pressed Steel Co., Jenkintown, Pa., has been made division manager of the Hallowell Pressed Steel Div. Mr. Bready graduated from Temple University in 1932 and joined Standard Pressed Steel the following year, progressing through various shop and toolroom jobs until 1941, when he was made purchasing agent. He was advanced to director of purchases in 1949.



we've built a GIANT

...to produce high vacuum in bigger chambers—at less cost—than ever before

Say you're producing one of the modern metals that has wonderful properties but can't stand oxygen at high temperatures.

You want to push out into the atmosphere as much air or gas as possible at the lowest cost. You may need to exhaust down to 1/2000th of atmospheric pressure or as low as 1/75,000th of an atmosphere.

CVC supplies a series of nonmechanical oil ejector pumps which can operate in this pressure range at rates well over 10,000 cubic feet per minute, compressing air and gas to the point where mechanical pumping becomes highly efficient—to pressures as high as 10 mm Hg where needed. And these unique pumps make possible a new order of operating economy for large high vacuum systems.

Whether your need is for a single pump or a complete high vacuum furnace we will welcome an opportunity to talk with you. Write to **Consolidated Vacuum Corporation, Rochester 3, N. Y.** (A subsidiary of Consolidated Engineering Corporation, Pasadena, Calif.)

CVC

formerly DPi Vacuum Equipment Dept.

Consolidated Vacuum Corporation

high vacuum research and engineering

Personals

Hugh D. Luke, formerly manager of central production planning, is now manager of manufacturing of rotating equipment at the Reliance Electric & Engineering Co., Cleveland. Mr. Luke joined Reliance in June 1953, having been with McKinsey & Co., management consultants, Boston, previously. He graduated from the University of Cincinnati in 1934, with a degree in chemical engineering, and was a lieutenant commander in the U.S. Navy during World War II.

David F. Snow has been appointed director of the copper division, Business and Defense Services Administration, U.S. Department of Commerce, and will serve the Government for a period of six months without compensation. Mr. Snow is on loan to BDSA from his post as district manager for the Bridgeport Brass Co., Bridgeport, Conn.

SENTRY

"ALWAYS ON DUTY"

DIAMOND BLOCK

ELECTRIC FURNACES FOR Air Hardening Steels



Scale-Free Heat Treating Essential to United

At United Tool and Die Company of W. Hartford, Connecticut, punches, dies and other tools of high carbon, high chrome steels receive careful heat treatment the Sentry way. Sentry electric furnaces with reliable Sentry Diamond Block atmospheric control assure maximum hardness with positive protection against surface deterioration.



Typical of parts treated is this cam. Hardening variables must be held to the minimum in its production.



Illustrates and describes all sizes of Models Y and YP Furnaces and The Sentry Diamond Block Method.

Request catalog U-35 . . . Modernize with Sentry and eliminate costly tool spoilage on Air Hardening and High Speed Steels. Simple, economical, reliable.

DIAMOND BLOCK

THE SENTRY COMPANY

FOXBORO, MASSACHUSETTS

E. Raymond Engstrand, a graduate of the Sheffield Scientific School at Yale University, has accepted the position of chief metallurgist at Ferro Powdered Metals, Inc., Salem, Ind., a wholly-owned subsidiary of Ferro Corp. Mr. Engstrand has served in the same position with the Yale and Towne Mfg. Co., American Sintered Alloys, Inc., Maguire Industries, and the Auto-Ordnance Corp., Bridgeport, Conn.

Louis Calzi has been appointed to the development metallurgical staff by Superior Tube Co., Norristown, Pa. Mr. Calzi was formerly employed by the Ajax Electric Co. in Philadelphia as a sales engineer.

William Alfred LaLande, Jr. was elected vice-president and will continue as manager of research and development at Pennsylvania Salt Mfg. Co., Philadelphia. Dr. LaLande, a graduate of the University of Pennsylvania, joined Pennsalt in 1944, and has been directing the research and development program at Wyndmoor, Pa., since 1948. From 1927 to 1937, he served as a member of the faculty of the University of Pennsylvania, and during the following year did post-doctoral work in organic chemistry at the Swiss Federal Polytechnic Institute in Zurich. Immediately prior to becoming associated with Pennsalt, Dr. LaLande was director of research and development for the Attapulgus Clay Co., Philadelphia.

Alfred H. Pope, formerly a member of the technical department at Pennsylvania Salt Mfg. Co., Philadelphia, has been named product supervisor in the chemical specialties division of the company. Mr. Pope is an alumnus of Pratt Institute where he majored in chemical engineering. He joined Pennsalt in 1943 as a member of its research and development staff.

Thomas C. Ford, formerly sales manager of Pittsburgh Metallurgical Co., Buffalo, N.Y., and **Robert C. Ford**, formerly Detroit district sales manager for Rolled Alloys, Inc., have opened a warehouse in Birmingham, Ala., and will operate as Ford Tool and Carbide Co., a metal cutting specialty house. Both brothers have been connected with the steel and metal industry for many years.



The Company faced with cold forming this thread rolled depressed head machine screw said, "We just wouldn't attempt to make it from any standard grade of 18-8!"

When this Company was asked to produce a second lot of these sheet metal screws from a regular 18-8, here was the reply: "Impossible —there's too much punch breakage!"

What would you do

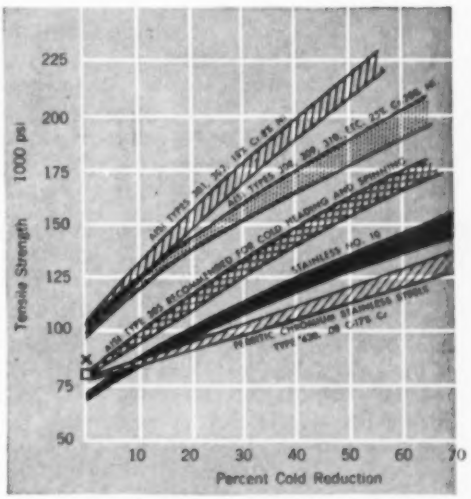
if you had to
mass produce
these fasteners
from 18-8 stainless
...without "losing your shirt"?

Both jobs were produced economically from a totally NEW chrome-nickel stainless!

Both companies successfully turned out these jobs with new Carpenter Stainless No. 10—the first chrome-nickel Stainless to permit economical, mass production of severely cold headed and upset fasteners and other parts. Carpenter No. 10 work-hardens far slower than any of the conventional 18-8 grades. That's the secret of its success. That is why it is ideal for cold headed bolts, screws, and upset nuts made on automatic machines. In fact, it is suited for any job involving heading, extrusion, severe coining and swaging. And the corrosion resistance of No. 10 is slightly better than Types 302, 304 and 305.

Upon request, we will be glad to give you more information about No. 10—its corrosion resistance, cold workability, machinability . . . as well as its usefulness for parts that must remain non-magnetic after severe cold working. So drop us a line on your Company letterhead, now . . . or any time. THE CARPENTER STEEL COMPANY, 133 W. BERN ST., READING, PA.

Export Department: The Carpenter Steel Co., Port Washington, N. Y. - "CARSTEELCO"



Comparison of various Stainless Steels showing increase of tensile strength with percentage of cold reduction.

more than corrosion resistance

Carpenter STEEL

Stainless No. 10

takes the problems out of production

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research

Personals

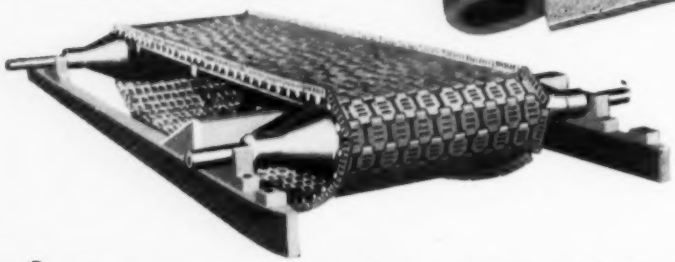
Glen W. Wensch has been appointed by Vitro Corp. of America to be the metallurgical engineering representative of the corporation in the atomic power reactor project now under study by 26 associated firms. Dr. Wensch joined Vitro in February of this year after serving for two years as chief of the materials branch of the Atomic Energy Commission at the Savannah River Operations Office in Georgia. He holds three degrees in metallurgical engineering from the University of Illinois, and was for two years staff metallurgist at the Los Alamos Scientific Laboratory in Los Alamos, N.M., and later was research metallurgist for the Fansteel Metallurgical Corp. in North Chicago, Ill.

Norman P. Norlie is now general sales manager of the Wilbur B. Driver Co., Newark, N.J.

NEW



OPEN-Link



STANDARD ALLOY BELT CONVEYOR

—offers new design possibilities in industrial furnaces for ANNEALING, NORMALIZING, STRESS RELIEVING, and DRAW OPERATIONS. Presents operating advantages in new industrial furnaces, and existing heat treating installations. Standard belt widths to fit drums, and rail or roller supports. Rugged construction assures long life.

DESIGN AND ENGINEERING DATA

—especially prepared for industrial furnace designers, engineers, and purchasing personnel.

Write for Form No. SA-1620.

Standard Alloys

COMPANY, INCORPORATED
1679 COLLAMER ROAD, CLEVELAND, OHIO

BUFFALO
C. M. Johnston Co.
1897 Elmwood Ave.

INDIANAPOLIS
Wm. McAtee
626 N. DeQuincy

CHICAGO
Elmer A. Terwell
4160 N. Elston Ave.

MILWAUKEE
Boden-Lindergren & Otto
1414 N. 27th

PITTSBURGH
Robert A. Schmidt
484 Frick Bldg.

CLEVELAND
Alloy Sales & Service
Chas. Plant, Jr.
Room 303, 8906 Lake Ave.

NEW YORK CITY
R. Brack Steele
254 W. 31st St.

DETROIT
Gehringer & Forsyth
16151 James Couzens Highway

HOUSTON
B. F. Coombs Co.
16170 Katy Rd.

PHILADELPHIA
Towle & Son
18 W. Chelten Ave. Bldg.

LONGMEADOW, MASS.
D. G. Constantine
Control Engineering Co.
51 Converse St.

LOS ANGELES
California Alloy Products Co.
2204 S. Atlantic Blvd.

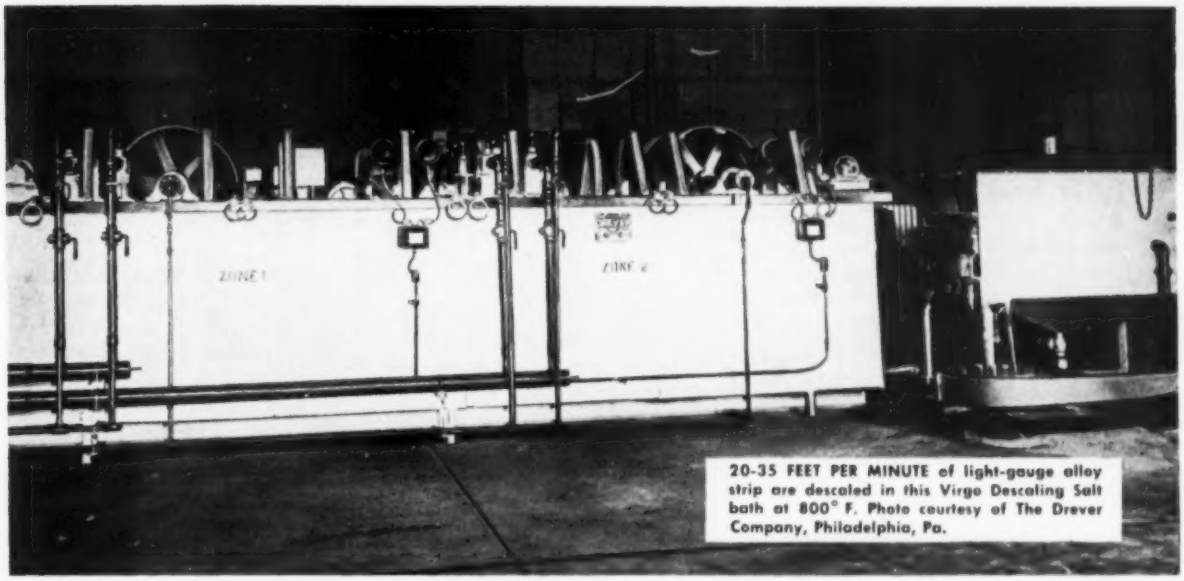
Earle C. Wood, field engineer with Leeds & Northrup Co., Philadelphia, recently received the company's 40th anniversary gold plaque. During his long service he has been closely identified with many of the instruments, automatic controls and furnaces which the firm produces. Mr. Wood joined Leeds & Northrup in 1914 as a shop apprentice. Eight years later he was transferred to the planning department, and in 1924 joined the sales department, where he specializes in the process-control problems of industry.

John A. Bennett, of the National Bureau of Standards, has received the Department of Commerce Silver Medal for Meritorious Service. The award was made for "very valuable contributions in the field of metallurgical science and technology, with particular reference to the mechanism of fatigue failures in metals, and for meritorious authorship". Mr. Bennett received his B.A. and M.S. from Cornell University in 1934 and 1935, respectively, and joined the staff of the National Bureau of Standards in 1936. At present he is chief of the mechanical metallurgy section of the Bureau. In this capacity he has participated in, and supervised investigations into, the cause of metal failures in general and particularly in welded ship plates, in airplanes, and other transportation equipment. He has published papers on both the theoretical and experimental phases of his work. Mr. Bennett has served as a member of the Publications Committee and is a past chairman of the Washington Chapter.

R. G. Nordstrom has been named general manager of the Reflectal Corp., New York, a subsidiary of Borg-Warner Corp., Chicago. Previously with Borg-Warner's Ingersoll Products Div., Mr. Nordstrom was assistant to the president and in charge of new product research.

Selden E. Doughty, previously chief metallurgist, has been appointed production manager of the Alloy Tube Div. of the Carpenter Steel Co. in Union, N.J.

Edwin T. Jackman has joined the sales staff of Vanadium-Alloys Steel Co., Latrobe, Pa., and will serve as a representative in the Detroit area.



20-35 FEET PER MINUTE of light-gauge alloy strip are descaled in this Virgo Descaling Salt bath at 800° F. Photo courtesy of The Drever Company, Philadelphia, Pa.

HOW TO

DESCALE 5½ MILES OF STRIP PER DAY

You can get clean bright surface in ONE operation with VIRGO® DESCALING SALT

Straight chrome and chrome nickel strip flow through this continuous descaling-annealing unit, at 25-35 feet per minute—about 5½ miles per 24 hour day.

The light-gauge strip is descaled in one pass through a bath of molten Virgo Descaling Salt at 800° F., after annealing. The process yields a chemically clean, bright surface with no pitting, etching or metal loss.

Large or small, your plant can show real production-time savings with the Hooker Process using Virgo Descaling Salt, or with the Virgo Molten Cleaner process. Use these processes on stainless and alloy steels; castings; forgings; fabricated parts; material to be salvaged. Both processes are non-electrolytic . . . non-toxic . . . employ simple equipment . . . do not require close supervision . . . are easily adapted to your production methods. For full details, mail coupon or write us today.

For Fast, Safe, Low-Cost DESCALING

VIRGO® DESCALING SALT—Producers and fabricators of stainless and alloy steels use Virgo® Descaling Salt to quickly remove scale produced by hot rolling, forging, extruding, casting, annealing.

VIRGO® MOLTEN CLEANER—Quickly, positively desands and degraphitizes castings; removes grease, dirt, chemicals, paint, enamel, rubber atmospheric corrosion and other impurities.

BOTH HOOKER PROCESSES are backed by 15 years' experience in salt bath descaling and cleaning. Engineering, research and on site operating assistance are part of our service.

SEND FOR THESE BULLETINS
They tell the whole story on Virgo Descaling Salt and Virgo Molten Cleaner—what they are, how they work, their advantages, equipment involved, and the Hooker services you enjoy as a user of the process.



Hooker Electrochemical Company
30 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.

Please send me Bulletins checked: Virgo Descaling Salt ☐ Virgo Molten Cleaner ☐

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE ____ STATE ____

HOOKER CHEMICALS ®

From the Salt of the Earth

HOOKER ELECTROCHEMICAL COMPANY
30 FORTY-SEVENTH ST., NIAGARA FALLS, N. Y.
NEW YORK, N. Y.
LOS ANGELES, CALIF.
TACOMA, WASH.
CHICAGO, ILL.

1-1445

Personals

Fred W. Beitner has been appointed manager of sales for the northeastern territory of Trent Tube Co., a subsidiary of Crucible Steel Co. of America, with headquarters in New York City. Mr. Beitner joined the sales department of Trent Tube in 1946, and at the time of his new appointment was sales manager for the company's Pittsburgh-Cleveland area.

Fred C. Raab, who began his career as a laboratory assistant in the Edison Chemical Works, Silver Lake, N.J., in 1904, retired the first of June as chief metallurgist at the Christy Park Works, National Tube Div. of United States Steel Corp., McKeesport, Pa. He remained with Edison Chemical Works until 1910, the last two years as chemist. In order to broaden his background, Mr. Raab held varied positions during the next few years, and in 1915 was appointed chief metallurgist of the Brown-Lipe-Chapin Div. of General Motors Corp., Syracuse, N.Y., where he remained until 1933. From 1933 to 1935 he was in charge of the metallurgical and inspection departments at the Babcock & Wilcox Co., Beaver Falls, Pa., going from there to the United States Steel Co., where he was superintendent of service at the Ellwood City Works. He went to Gary, Ind., in 1940 in the same capacity, and in 1946 was transferred to Christy Park for the job he held until his retirement. Mr. Raab does not intend to quit work altogether, however. He is now living in Royal Oak, Mich., where he plans to open a "trouble shooting" metallurgical laboratory.

Charles C. Eeles has been transferred from Toledo, Ohio, where he was district industrial and commercial sales manager for the Ohio Fuel Gas Co., to the general offices of the company in Columbus with a promotion to assistant manager of industrial and commercial sales. Mr. Eeles started work for Ohio Fuel in Warren, Ohio, in 1929, shortly after receiving a degree in mechanical engineering from Cornell University. Later that year he was transferred to Toledo and has remained there since that time. He is chairman of the Industrial and Commercial Gas Section of the American Gas Association and will serve on the faculty of the AGA's commercial gas school this year. He has written many technical papers on the use of gas in the industrial and commercial field.

Jack E. Bolt has been appointed application engineer in the phenolics engineering unit, chemical materials department of the chemical division of General Electric Co., Pittsfield, Mass. Mr. Bolt is a graduate of Georgia Institute of Technology with a B.S. degree in mechanical engineering. He received his master's degree in metallurgical engineering at the University of Alabama. Mr. Bolt went to the General Electric Co. from the U.S. Naval Reserve where he had been on active duty for three years. Prior to this he was a metallurgist and supervisor at the American Brake Shoe Co. He also served in the Navy during World War II.

Paul W. Chase has completed work for the degree of bachelor of metallurgical engineering at the University of Minnesota and is employed in the research division of the Quaker Oats Co., Akron, Ohio.

Albert R. Potenski has been transferred from the Eclipse-Pioneer Div. of Bendix Aviation Corp. at Teterboro, N.J., to the Utica, N.Y., division, with a promotion to senior metallurgist.

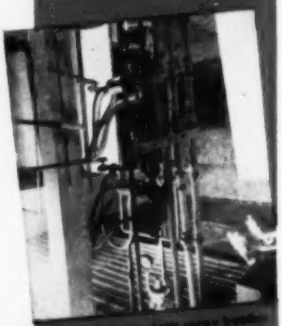
PRODUCTION INCREASED 150% with DESPATCH FINISHING SYSTEM



Amana World's Largest Manufacturer of Food Freezers Expands

As part of a major expansion program Amana Refrigeration, Inc., Amana, Iowa, installed a DESPATCH 2-coat, 2-bake electrostatic paint finishing system with a capacity of 400 freezers and 200 room air conditioners on an 8-hour shift. The new streamlined system is credited with increasing Amana's production by 150%, has greatly improved finish quality and has achieved substantial paint savings through more efficient paint application and paint reclamation processes.

Ware travels on a 2700-foot continuous conveyor through 5-stage washer, dry-off oven, prime and finish staggered electrostatic spray booths, prime and finish touch up booths, prime and finish multiple pass bake ovens and inspection area to three assembly lines.



A COMPLETE SYSTEM OR A SINGLE UNIT

Despatch Finishing Systems are designed and built to finish your product better, faster and more economically. You can get a complete system or an individual unit. Write, Wire or Call Dept. P for details.

DESPATCH OVEN COMPANY

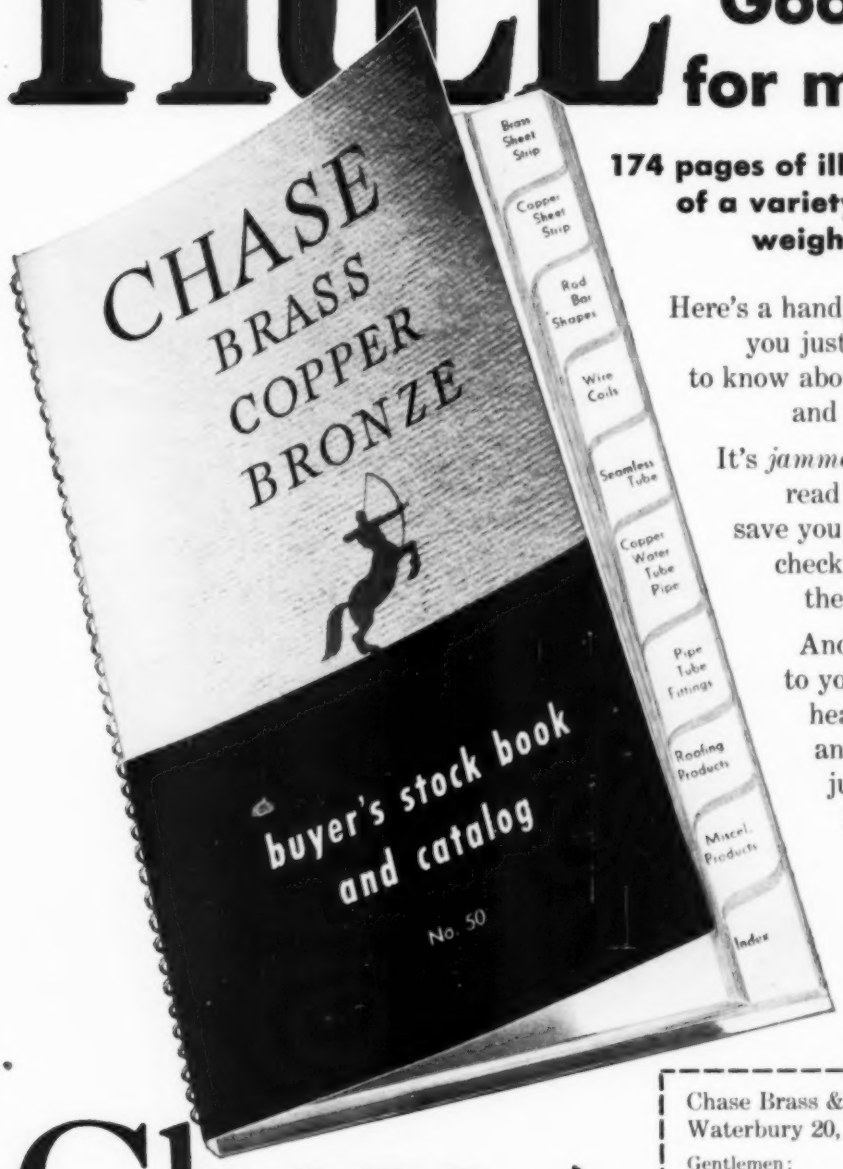
Minneapolis Office 619 S.E. 8th St. Chicago Office 4334 N. Broadway

Sales and Service in all Principal Cities

PIONEERS IN ENGINEERING HEAT APPLICATIONS FOR INDUSTRY

FREE

Good reading for metal men!

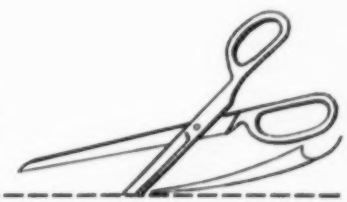


174 pages of illustrations and listings of a variety of products...sizes... weights...tempers...shapes!

Here's a handy, desk-size book that gives you just about *everything* you need to know about brass, copper and bronze and now . . . stainless steel, too!

It's *jammed to the brim* with easy-to-read data. It's *thumb-indexed* to save you time. It has a how-to-order check list that's designed to take the headaches out of ordering.

And what's more, it comes *free* to you from Chase—the nation's headquarters for copper, brass and bronze. To get *your* copy, just clip and mail the coupon below.



Chase Brass & Copper Co.
Waterbury 20, Conn. Dept. MP 754

Gentlemen:
Please send me your Buyer's Stock Book and Catalog.

NAME_____

POSITION_____

FIRM_____

STREET_____

CITY_____ STATE_____

Chase

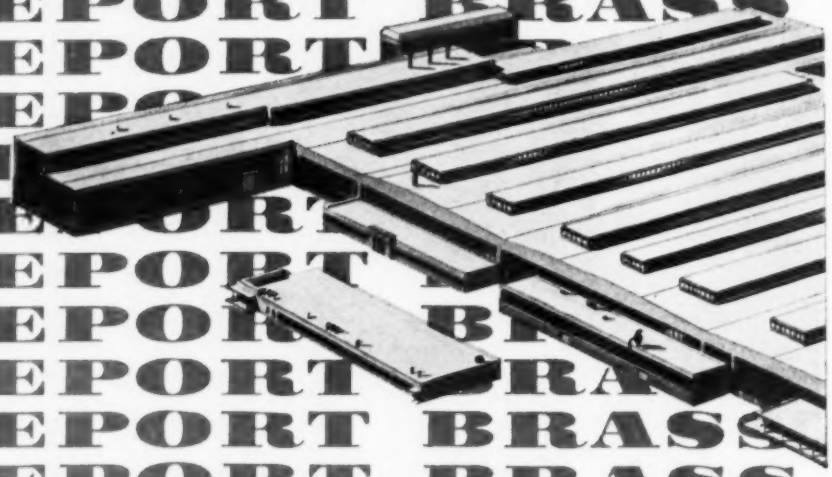
BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

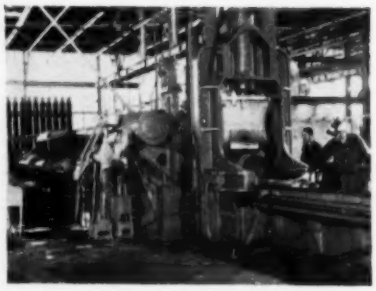
Albany†	Chicago	Denver†	Kansas City, Mo.	Newark	Pittsburgh	San Francisco
Atlanta	Cincinnati	Detroit	Los Angeles	New Orleans	Providence	Seattle
Baltimore	Cleveland	Houston	Milwaukee	New York	Rochester†	Waterbury
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(†sales office only)

BRIDGEPORT BRASS

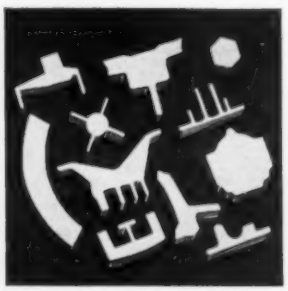


The Adrian, Michigan, Plant of Bridgeport's Aluminum Division—a fully-integrated mill of over 800,000 sq. ft.

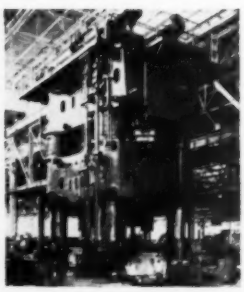
From a Background of 89 Years of Experience in Metals Comes Bridgeport Aluminum



Bridgeport's 16 extrusion presses for light metals production, ranging from 1,650 to 5,500 tons, can make extrusions in many alloys.

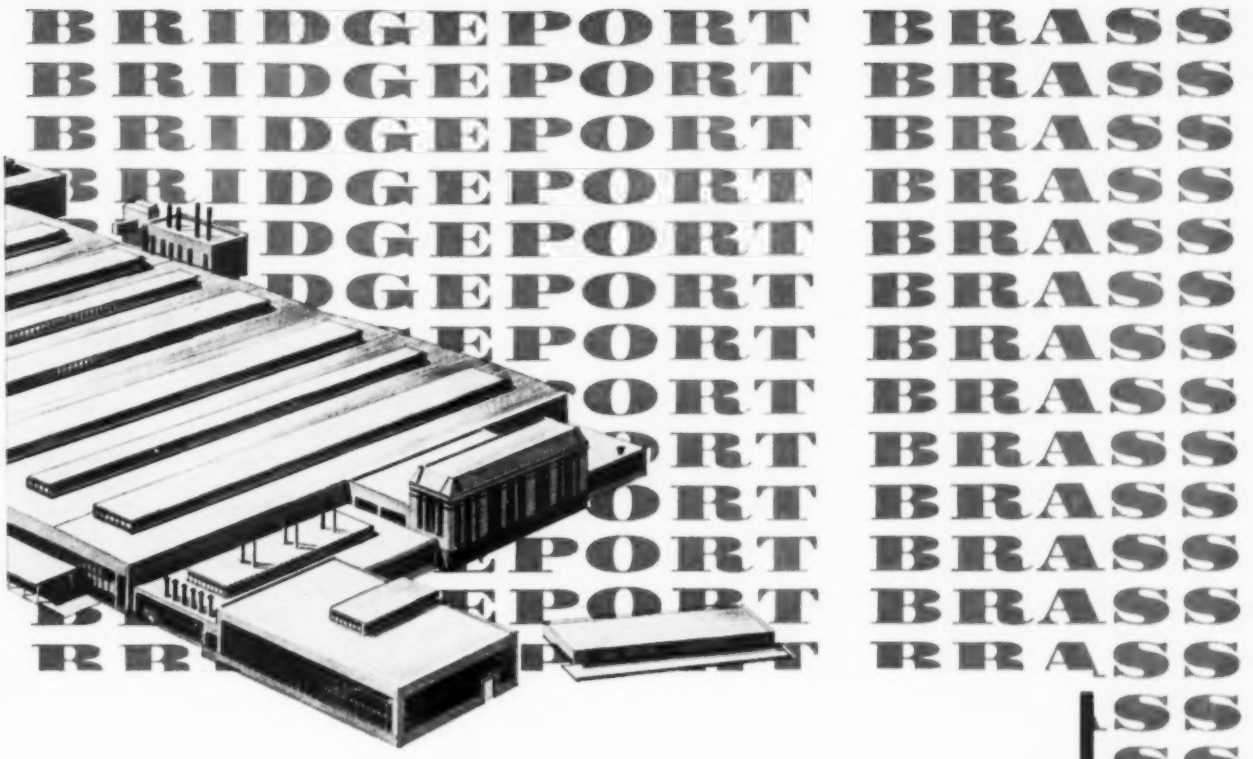


The wide range of extrusions produced by Bridgeport offer unlimited design and production possibilities.



Facilities for producing quality forgings include this huge, 16,500-ton hydraulic press.

BRIDGEPORT



Users of Aluminum Extrusions and Forgings now have a new and highly dependable source of supply—the Aluminum Division of the Bridgeport Brass Company.

Behind this new service in aluminum are eighty-nine years of pioneering experience in metal production and research. Bridgeport's reputation for quality and high standards is recognized throughout the metal industries. And its aluminum production facilities are among the nation's finest.

The services of Bridgeport's nation-wide sales and engineering facilities are at your command. And the skills and knowledge of our research and technical services, gained through decades of metalworking experience, are yours to apply in the solution of your aluminum problems.

Call our local sales office nearest you for complete information and service on Bridgeport's aluminum products.

BRIDGEPORT BRASS COMPANY
ALUMINUM DIVISION • Bridgeport 2, Conn.
Sales Offices in Principal Cities
Conveniently Located Warehouses
Mills at Bridgeport, Conn.,
Indianapolis, Ind., and Adrian, Mich.



Aluminum die forgings made to meet exacting demands. Contour hand forgings are also produced.



This Quantometer for analyzing metal is typical of the laboratory equipment which assures you the finest quality extrusions and forgings.



Write for your copy of this booklet describing Bridgeport's Aluminum Division facilities.

Bridgeport **ALUMINUM**

UNITED STEEL DRUMS

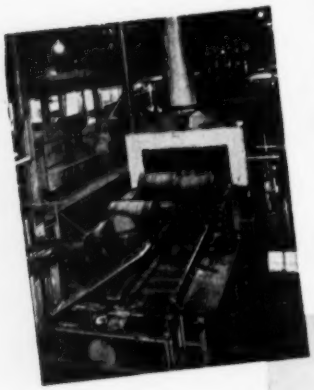
ARE

Granodized

WITH GRANODINE®

FOR EXTRA PROTECTION

Steel Drums made by United Steel Barrel Company of Philadelphia, Pennsylvania, are chemically cleaned and phosphate coated in an integrated spray Granodizing process:



1. **ALKALI CLEANING** removes oil, grease, fingerprints, hand-marks, other surface soil;
2. **SULFURIC ACID PICKLING** then removes mill scale;
3. **GRANODIZING** converts the chemically cleaned steel surface to a uniform phosphate coating. The "Granodine" coating being non-metallic is an ideal bond into which the paint finish is "keyed" or anchored;
4. **"DEOXYLYTE" final acidulated rinsing** conditions the Granodized steel surface for optimum paint life.



UNITED DRUMS fabricated from Standard Gauge Steel are available in all sizes, with special linings for a variety of products, and decorated with any desired design.

- **EXTRA PROTECTION** for the finish—a lasting bond between paint and steel.
- **EXTRA PROTECTION** for the steel container—an inert barrier against rust creepage.
- **EXTRA PROTECTION** for the contents—chemically clean interior surfaces.
- **EXTRA PROTECTION** for the customer—an assurance of cleanliness, durability, and fine appearance.

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

CHEMICALS ACP PROCESSES

General Offices: Ambler, Penna.

CHEMICALS ACP PROCESSES

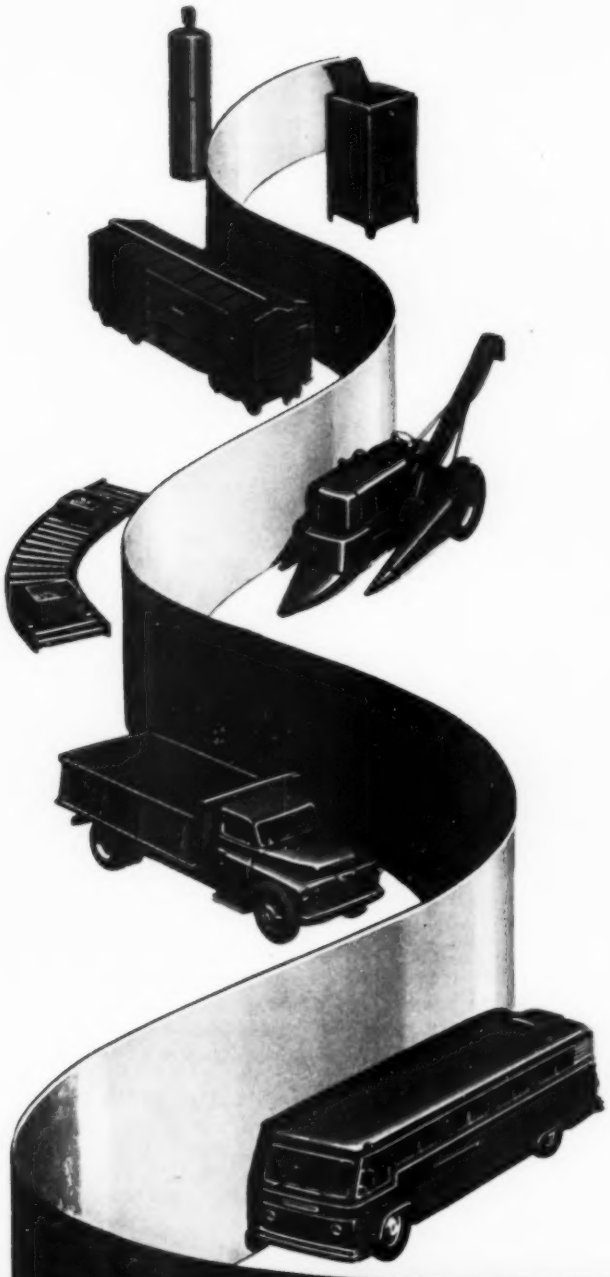
Detroit, Michigan **Niles, California** **Windsor, Ontario**

Personals

C. L. T. Edwards has retired from Bethlehem Steel Co. after approximately 40 years of service, variously as openhearth melter, superintendent of blast furnaces at Bethlehem, the Lebanon-Cornwall Div., Coatesville furnaces and for the past 23 years specializing in manganese sales. Mr. Edwards served with the Donald Nelson Mission to China in 1945 and with the Industry Evaluation Board in 1951.

Carl M. Loeb, Jr. has resigned as vice-president in charge of sales and research of Climax Molybdenum Co., New York City, but remains a member of the board of directors and chief technical adviser to the company. Mr. Loeb joined Climax in February 1932 as a research assistant in the Detroit laboratory. Late that year he became district sales manager in New York and served in that post until he was made vice-president in charge of sales development in 1937. In 1948 he was made a member of the board of directors. He graduated from Princeton University in 1926 and received his M.S. from M.I.T. in 1928.

Thomas E. Eagan, chief research metallurgist of the Cooper-Bessemer Corp., Mount Vernon, Ohio, and Grove City, Pa., has been awarded the Joseph S. Seaman Gold Medal by the American Foundrymen's Society. The award was presented to Mr. Eagan for his "outstanding work in the development and dissemination of engineering data on the production and utilization of alloy cast irons." A graduate of Columbia University with an A.B. degree in 1923, Mr. Eagan received the B.Sc. degree in metallurgy from the Missouri School of Mines and Metallurgy in 1925, and the metallurgical engineering degree in 1928. Before becoming associated with Cooper-Bessemer in 1934, he was affiliated with Simonds Saw and Steel Co., Crucible Steel Co., and the Midvale Co. A past national director of the American Foundrymen's Society, Mr. Eagan is also a member of the American Institute of Metallurgical Engineers, the American Society of Testing Materials, the Society of Automotive Engineers, and British Iron and Steel Institute.



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

It is 50% stronger than mild steel.
It is considerably more resistant to corrosion.
It has greater paint adhesion with less undercoat corrosion.
It has high fatigue life with great toughness.
It has greater resistance to abrasion or wear.
It is readily and easily welded by any process.
It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

Sound like something for you? Ask for full facts and think of N-A-X HIGH-TENSILE when you re-design.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Make it **WEIGH LESS**... and **LAST LONGER** with

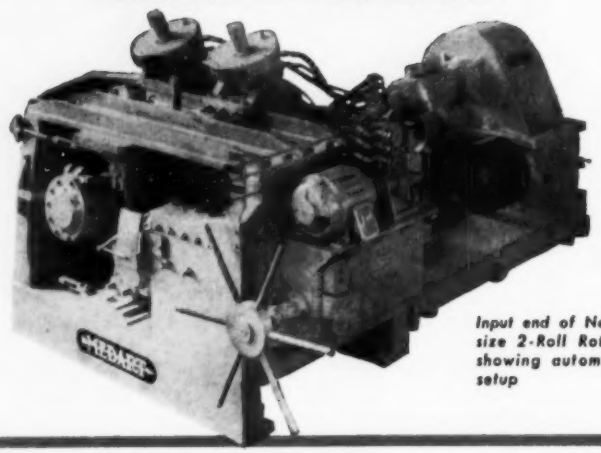
N·A·X

HIGH-TENSILE STEEL

Now! Automatic Set-Up Of Precision Bar Straightener!

MEDART

2-ROLL ROTARY STRAIGHTENER SIZER & POLISHER



Input end of No. 3 size 2-Roll Rotary showing automatic setup

- Full automatic adjustment of straight roll
- Full automatic adjustment of concave roll
- Full automatic adjustment of bending pressure and roll opening for bar sizes
- New style large numbered scales for roll angles plus new scale for bar size
- Precision straightens, sizes and polishes, and corrects out-of-roundness, from end to end, on any round ferrous or non-ferrous workpiece, solid or tubular
- Puts a super finish (10 micro-inch or better) on cold-drawn, turned and ground stock
- Removes mill scale from hot-rolled surfaces
- Improves the physical properties of the workpiece
- End-to-end feeding, with 2-direction operation, gives continuous uninterrupted sizing and polishing at high throughput speeds

Write For Complete Catalog!

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MO.

Personals

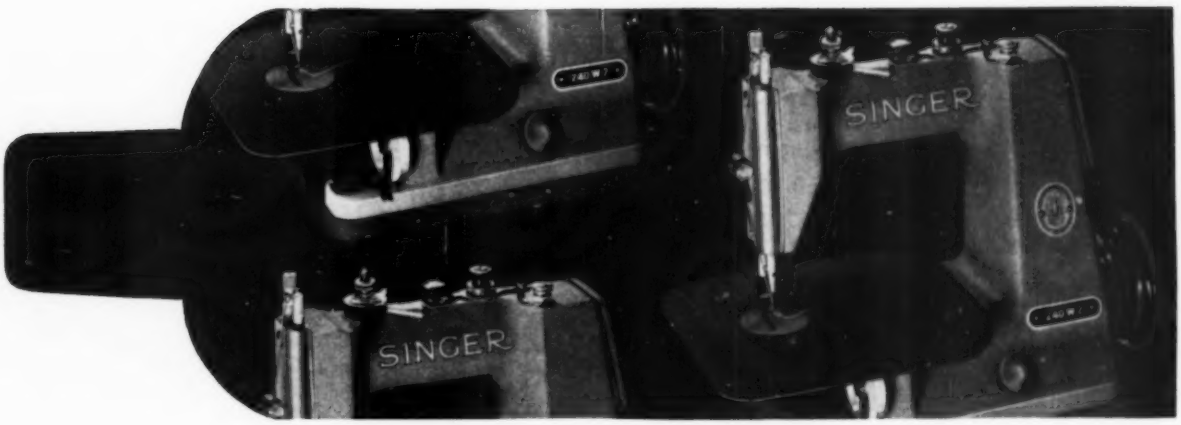
Nelson C. George, formerly assistant chief metallurgist at Gary (Ind.) Sheet and Tin Mill of United States Steel Corp., has been promoted to chief metallurgist. He succeeds **John A. Eckel**, who has been promoted to assistant to the general superintendent at U. S. Steel's Fairless Works in Morrisville, Pa. **William W. Hintalla**, sheet division metallurgist, has been appointed to succeed Mr. George. Mr. George started with Gary Sheet and Tin Mill in 1936 as a laboratory technician after graduation from Purdue University with a B.S. degree in chemical engineering. He was promoted to assistant metallurgist in 1937, and in 1938 he was named general supervisor in the tin division. In 1953 he was promoted to assistant chief metallurgist. Mr. Eckel has been associated continuously with the Gary Sheet and Tin Mill since his graduation from Carnegie Institute of Technology in 1935 with a B.S. degree in metallurgical engineering. He started as a junior metallurgist in February 1936, advancing through various positions until his appointment in 1941 to the position of metallurgist in the sheet division. In 1949 he was promoted to chief metallurgist. Mr. Hintalla was graduated from the Montana School of Mines in 1937, and in the same year joined the Gary Sheet and Tin Mill as a junior metallurgist. After several supervisory positions, he was made sheet division metallurgist.

Attwell M. Adair (1st Lt., U.S. A.F.) has received the degree of M.Sc. in metallurgy from Ohio State University and is now project engineer in the metallurgical branch, aeronautical research laboratory, Wright Air Development Center, Wright-Patterson Air Force Base.

Frank Trexler, formerly employed in the research department of Lukens Steel Co., Coatesville, Pa., is now a sales engineer in the new Fosbond department of the Pennsylvania Salt Mfg. Co., Philadelphia.

Frank H. Holmes has retired from active duty as a colonel in the U.S. Air Force. Colonel Holmes has a total of more than 30 years' service in the reserve, national guard, and regular army.

Armour ammonia helps Singer build a machine that sews 83 stitches per second!



Case hardening the key parts was the problem.
Here's how Singer's Bridgeport engineers solved it!

With Singer industrial sewing machines operating at speeds up to 5,000 stitches a minute on all kinds of materials, wear of certain parts is a major problem. The use of Armour ammonia in case hardening vital parts for high-speed machines by nitriding and carbonitriding has enabled us to lengthen the wear-resistant qualities of these machines.

"Better hardness, elimination of surface removal by cleaning, and the reduction of secondary operations have contributed to producing newer and better machines, which are operated at higher speeds with reduced wear. This has been made possible through the use of Armour ammonia in surface hardening processes."

Chief Metallurgist, Bridgeport Works,
The Singer Manufacturing Co.

Extra benefits with Armour ammonia

When you buy Armour ammonia, you get pure, dry, dependable ammonia, and you get it fast! Besides that, we send you the latest information on surface hardening (like the 8 free booklets offered at right). And, if you need assistance with one of these new processes, experienced men in our Technical Service department will help you install the equipment!

Armour sponsors a fellowship at Massachusetts Institute of Technology for the study of modern metal treating. Information from this basic research is also available to you.

So take advantage of Armour's special service. Order Armour Ammonia today!



Save money on our tank truck delivery service!



CLIP AND MAIL THIS TODAY!

Please send me free copies of the booklets which I have checked:

- ☐ "Ammonia Cylinder Installations for Metal Treating"
- ☐ "Effective Use of Dissociated Ammonia"
- ☐ "The Nitriding Process—Factors Influencing Ammonia Consumption"
- ☐ "A Survey of Industrial Carbonitriding Process"
- ☐ "The Constitution of Carbonitrided Cases"
- ☐ "Investigation into the Carbonitriding of Plain Carbon Steel"
- ☐ "The Carbonitriding of Alloy Steels"
- ☐ Tank truck service information

Name ..... Title .....

Firm .....

Address .....

City ..... Zone ..... State .....

P7

ARMOUR *Ammonia Division*

Armour and Company • 1355 West 31st Street
Chicago 9, Illinois



Personals

Alvin J. Herzig has been elected vice-president in charge of research of Climax Molybdenum Co., New York. Mr. Herzig has been president of the Climax Molybdenum Co. of Mich., the research subsidiary of Climax in Detroit, since 1949, and for five years prior to that he served as vice-president in charge of the laboratory. He had been research associate in the department of engineering research at the University of Michigan when he joined the Climax laboratory in 1931. Mr. Herzig is a member of the Subcommittee on Heat Resisting Materials of the National Advisory Committee for Aeronautics and the Materials Advisory Board of the National Research Council.

Louis W. Horvath, formerly sales manager of Flinn & Dreffein Engineering Co., Chicago, has been appointed vice-president. His duties will include the supervision of research and general furnace sales.

E. A. Brophy, Detroit district sales manager for the Braeburn Alloy Steel Corp., Braeburn, Pa., for the past 18 years, has been appointed a vice-president of the corporation. Mr. Brophy, a member of the American Society for Metals for 25 years, has been with Braeburn for 29 years, serving first as metallurgist at the plant, and has been in the Detroit area for 25 years.

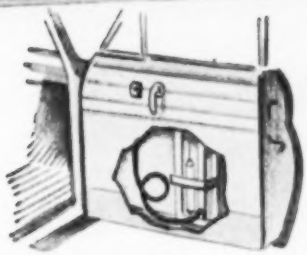
Stanley W. Madsen has been appointed assistant vice-president of the Shieldalloy Corp., Div. of Metallurg, Inc., New York.

Paul M. Offill, Sr., who recently retired as vice-president in charge of sales for the Amsler Morton Corp., Pittsburgh, after more than 28 years of active service, has been appointed general sales consultant for the Geo. P. Reintjes Co., Kansas City, Mo., with headquarters in Pittsburgh.

Harry M. Heckathorn, formerly executive vice-president of Mullins Mfg. Corp., Salem and Warren, Ohio, is now president of the company.

Anson B. Albree is now employed as sales metallurgist in the New England states for Rolled Alloys, Inc., Detroit.

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*

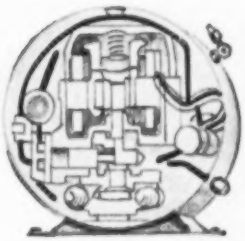


AUTOMOTIVE HYDRAULIC WINDOW LIFT LINES

FRAME FOR OCCASIONAL TABLE



REFRIGERATOR COMPRESSOR LINES



REMARKS Do you have a tubing design that won't jell -- or a fabrication kink you can't untangle? Whatever your tubing headache, why not turn it over to our engineering experts. They offer you years of problem-solving experience, plus the added bonus of Bundyweld, the only tubing double-walled from a single strip (see below).

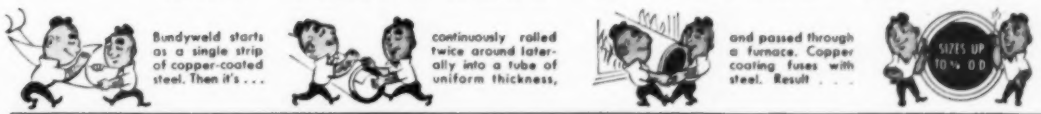
WRITE today for catalog or for help in developing your tubing ideas.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



SUPERMARKET PUSHCART FRAME

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

BUNDYWELD TUBING®

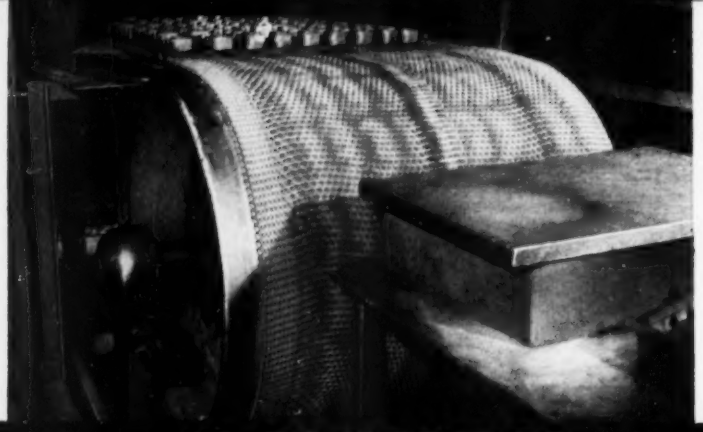
DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Takes plating
Bright and clean
No inside bead
Uniform I.D., O.D.

Bundy Tubing Distributors and Representatives: ***Bridgeport, Conn.:*** Karhumel Steel & Aluminum Co., 117 E. Washington St. • ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Ritan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E.

Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

idea for AUTOMATION



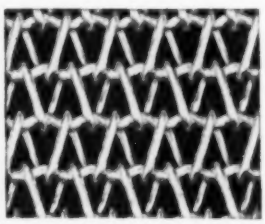
with CAMBRIDGE
Woven Wire Conveyor Belts

CONTINUOUS BRAZING

Metal products can be heat treated, quenched and cooled in one continuous series of operations on Cambridge belts. All-metal belt is unharmed by temperature, quench oils or sharp-edged, heavy loads.

If you're still heat-treating by costly, time-wasting batch operations you'll find Cambridge Woven Wire Conveyor Belts help provide cost-cutting, automatic production by allowing you to process the work *continuously*. No batch operations, less manual handling for such processes as: annealing, tempering, brazing, sintering, soldering, as well as quenching, pickling, oiling, washing.

OPEN MESH CONSTRUCTION of the belt provides free circulation of heat-treating atmospheres for uniform processing, free drainage of process solutions. Of course, the all-metal construction means lowest maintenance cost.



CAMBRIDGE BELTS are available in any metal or alloy. Thus, the belt recommended for you can be fabricated from the specific material that will give longest belt life under your operating conditions. In addition, Cambridge belts can be woven to any length or width and in a wide variety of weaves and mesh sizes to meet your needs.

FREE REFERENCE MANUAL gives full details on how Cambridge belts can boost output, cut costs by providing continuous, automatic production . . . *automation!* Includes all specifications and details, also metallurgical tables. Write for your copy today! Or, for specific recommendations, call in your Cambridge Field Engineer. He's listed under "Belting-Mechanical" in your classified 'phone book.



The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department B
Cambridge 7, Maryland

OFFICES IN LEADING INDUSTRIAL AREAS

Personals

Charles W. Keshler, after being ordered to inactive duty by the U.S. Navy, is now employed as a service engineer in the Wichita, Kan., division of the Boeing Airplane Co.

Wilson A. Young has been promoted by Joseph T. Ryerson & Son from manager of the alloy and stainless steel department of the Pittsburgh plant to district sales manager of the company's new plant in Charlotte, N.C.

Albert H. Wilson is now representing Rolled Alloys, Inc., Detroit, Mich., as district salesman in the Cleveland-Pittsburgh area.

George E. Heizman, Jr., formerly associated with Acme Aluminum alloys, Inc., Dayton, Ohio, as chief metallurgist, is now a research project engineer with Butler Mfg. Co., Kansas City, Mo.

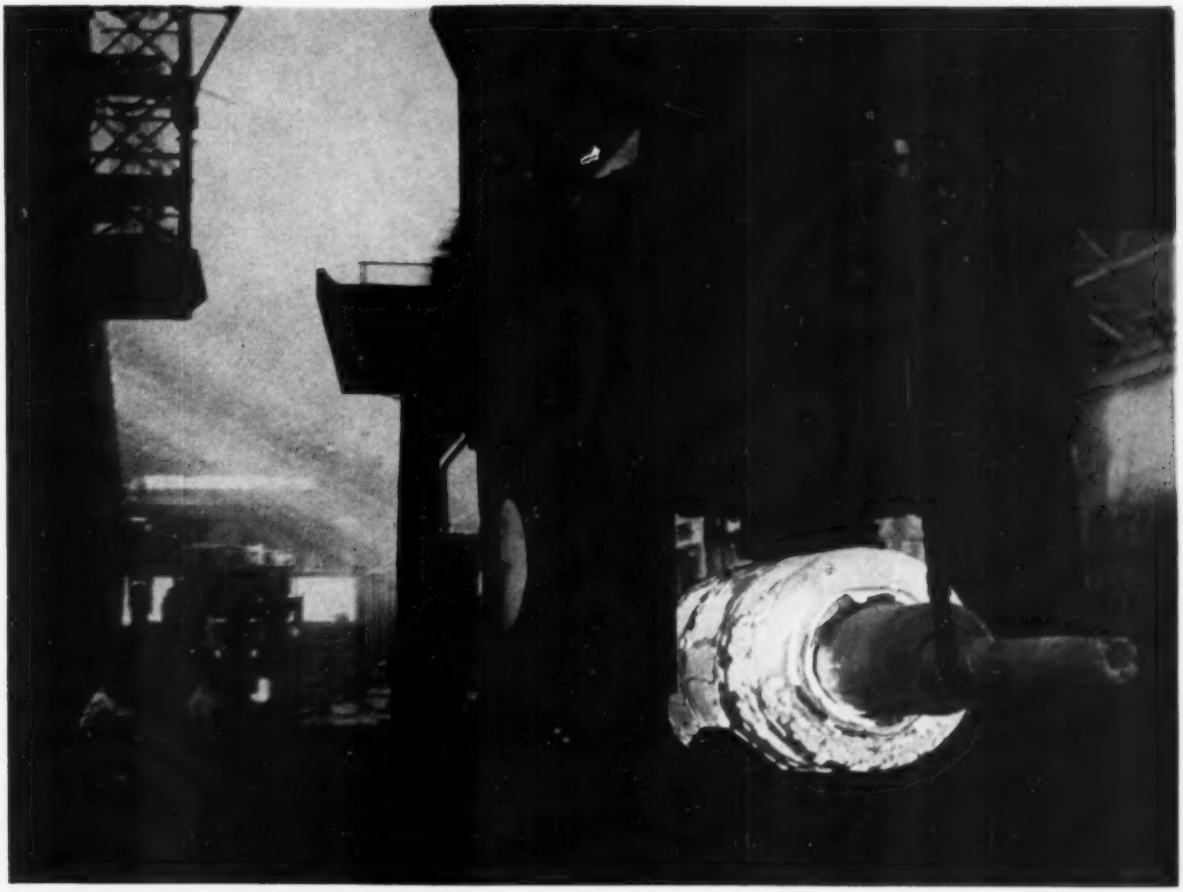
Garnet G. Eller, formerly metallurgist with Atlas Steels, Ltd., Welland, Ont., is now employed as laboratory supervisor for Automatic Electric, Ltd., Brockville, Ont.

Mervin T. Rowley has resigned as assistant division chief of physical metallurgy at Battelle Memorial Institute and is now chief metallurgist at the Ohio Injector Co., Wadsworth, Ohio. Mr. Rowley was employed by this company as assistant metallurgist prior to joining Battelle.

Joseph E. Carney was recently appointed chief metallurgical engineer of Sun Oil Co., Philadelphia. He joined the company in 1934, was subsequently made chief inspector, metallurgical section, and in 1951 became assistant chief metallurgical engineer.

Robert L. Hadley has been transferred from the Knolls research laboratory of General Electric Co., Schenectady, N.Y., where he was employed as research associate in the metallurgy department, to the major appliance division laboratory, Louisville, Ky., with a promotion to engineering manager in metallurgy and ceramics.

William R. Yankee, formerly research associate at Columbia University, is now employed as a research engineer at Metals & Controls Corp., Attleboro, Mass.



MIDVALE FORGINGS...*Shape up for tougher service*

As the giant press forges the 500,000 pound ingot, careful experienced hands guide every stroke . . . size and shape it to the required dimensions. Careful working and heating will finally shape this forging to an overall length of 46'-4¼" with an outside diameter of 61½".

Midvale forging quality is the result of absolute control from start to finish. From the time the scrap and pig iron are charged into the open hearth or electric furnaces "quality tests" and skilled hands take over. Ingots are forged on presses ranging from 1,500 tons to 14,000 tons capacity. Heat treating cycles based on Midvale's long experience are thoroughly followed to produce the maximum in mechanical properties. Final machining is done on equipment capable of handling rough or finish machining on practically any size product.

This is the reason Midvale forgings—whether 300 or 300,000 pounds are noted for their toughness, long service and never failing performance. The men of Midvale working with the right equipment and facilities offer a source of forgings, steel mill rolls and rings unsurpassed in quality and extra performance. Let their services, long experience and willingness help solve your forging problems.

THE MIDVALE COMPANY- Nicetown, Philadelphia 40, Pa.

Offices: New York, Chicago, Pittsburgh, Washington, Cleveland, San Francisco

MIDVALE

FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS



PrePARED

ON A PRODUCTION BASIS TO GIVE YOU:

1. Bright, smooth surfaces to close tolerances . . .
2. Uniform straightness of bars
3. Greatly improved machinability
4. Minimized warpage or distortion
5. Fewer additional machining or grinding operations

WYCKOFF COLD FINISHED STEEL BARS

CARBON . . . ALLOY . . . LEADED



Enjoy these and other cost saving advantages by standardizing on Wyckoff Bars—our metallurgical staff will be glad to cooperate with you in selecting the best grade of steel for your particular requirements.

WYCKOFF STEEL COMPANY

General Offices: Gateway Center • Pittsburgh 30, Pa.

Branch Offices in Principal Cities

Works: Ambridge, Pa. • Chicago, Ill. • Newark, N. J. • Putnam, Conn.

Kanigen Nickel Plating

References

(See article starting on p. 113)

1. "Nickel Plating on Steel by Chemical Reduction" and "Deposition of Nickel and Cobalt by Chemical Reduction", by Abel Brenner and Grace Riddell, *Journal of Research* of the National Bureau of Standards, Vol. 37, July 1946, and Vol. 39, November 1947, respectively.

2. "Sur l'hydrure de cuivre", by Adolphe Wurtz, *Comptes rendus hebdomadaires des scéances de l' Academie des Sciences,* Vol. 18, April 15, 1844, p. 702.

3. U. S. Patent 1,207,218, to Roux, Dec. 5, 1916.

4. "Spaltung des Wassers durch Hypophosphite in Gegenwart von Palladium als Katalysator", by A. Bach, *Berichte der Deutschen Chemischen Gesellschaft,* Vol. 42, November 1909, p. 4463.

5. "Uber den Mechanismus der Oxydationsvorgange VI", by Heinrich Wieland, and "Uber die Oxydation der phosphorigen Saüre", by Heinrich Wieland and Aug. Wingler, *Annalen der Chemie,* Vol. 434, Nov. 26, 1923, p. 198.

6. "Der Mechanismus der Hypophosphitspaltung nach Versuchen mit Deuterium als Indicator", by Wilhelm Franke und Joseph Mönch, *Annalen der Chemie,* Vol. 550, June 1942, p. 1.

7. "Uber Schwermetallphosphide, I. Einwirkung von Hypophosphite auf Nickel und Kobaltsalze", by R. Scholder and H. Heckel, *Zeitschrift fur anorganische und allgemeine Chemie,* Vol. 198, July 1, 1931, p. 329.

8. "Einwirkung von Hypophosphite auf Nickelund Kobaltsalze (II Mitteil. uber Schwermetallphosphide)", by R. Scholder und H. L. Haken, *Berichte der Deutschen Gesellschaft,* Vol. 64, December 1931, p. 2870.

9. U. S. Patent 2,658,841, to Gutzeit and Krieg, Nov. 10, 1953 (Filed Nov. 8, 1950).

10. U. S. Patent 2,658,842, to Gutzeit and Ramirez, Nov. 10, 1953 (Filed Jan. 4, 1951).

11. U. S. Patent 2,658,839, to Talmey and Crehan, Nov. 10, 1953 (Filed April 21, 1951).

THE IDEAL METHOD:

INDUCTION MELTING

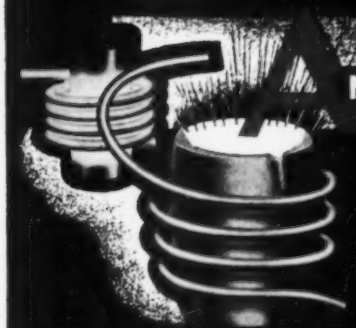
with converter-operated furnaces

Wherever metals are heated or melted in small quantities . . . for steel, non-ferrous or precious metal casting, sintering or hot pressing carbides, brazing . . . these self-tuning, low cost converter-operated furnaces are virtually standard equipment.

Ajax-Northrup converters are certified to meet F. C. C. regulations. Furnaces are available in sizes from 2 ozs. to 120 lbs. (For large production—Ajax-Northrup generator-operated furnaces.)

Write for Bulletin 14.





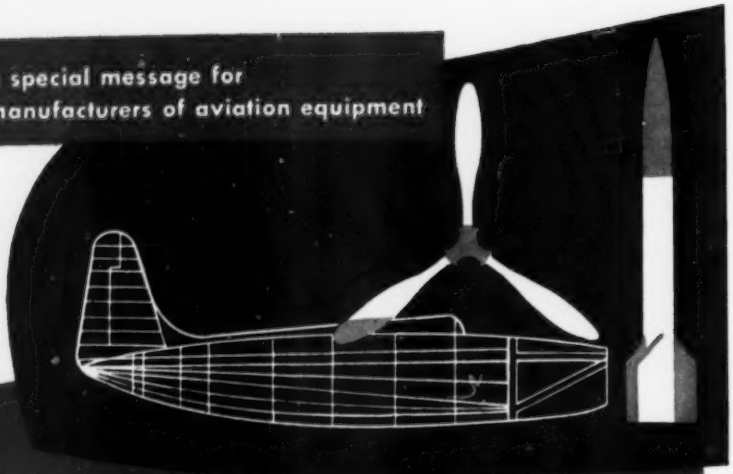
NORTHRUP SINCE 1916

INDUCTION HEATING MELTING

AJAX ELECTROTHERMIC CORPORATION • TRENTON 5, NEW JERSEY

ASSOCIATED COMPANIES: AJAX ELECTRIC FURNACE CORPORATION • AJAX ELECTRIC COMPANY • AJAX ENGINEERING CORPORATION

a special message for
manufacturers of aviation equipment



need a finish for
light metal parts?

specify
IRIDITE

Here's the finish that combines corrosion resistance and paint adherence with extreme ease of application. It can be welded or soldered with no difficulty and presents no problem in "patching" scratches, marks or scraped sections. Here's what you can do with Iridite:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified phone book.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacture of Large Forgings*

In his concluding remarks, the author states: "This paper has attempted to paint a picture of all operations involved in making large forgings". To anyone acquainted with this subject, this is clearly a formidable task, but the author has succeeded admirably and, in doing so, has held the reader's interest from start to finish.

The two chief examples selected to illustrate the subject are a very large press column and a large shaft forging for hydro-electric power generation. This choice seems very appropriate because of the complications of precautionary heat treatments which are necessary for large masses of alloy steel, as for the former, and the complications of a sequence of forging operations which are needed for components such as the latter.

The press column, which must be one of the world's largest alloy steel forgings, required the casting of a mammoth ingot. The description of this operation, together with that of the subsequent forging and heat treatment of the column, is lucidly given in a manner that will appeal to all forgemasters with experience in the manufacture of large pieces. Also, they will be able to appreciate fully the formidable task of synchronizing four separate furnace heats required for the manufacture of an ingot weighing 672,000 lb., and the subsequent forging and heat treatment of a column 47 in. diameter and 71 ft. long.

From the point of view of the metallurgist, perhaps the most fascinating part of Mr. Schaefer's paper is the description of the precautionary heat treatments carried out subsequent to No. 3 forging operation and again after the final forging operation, No. 6. The latter, especially, is obviously the result of much thought and experience, but will certainly cause some lively discussions (as indicated by Mr. Schaefer in his reference to the results of two or three manufacturers' meetings).

(Continued on p. 150)

*Digest of "Manufacture and Properties of Large Forgings", by A. O. Schaefer, a paper presented at the Philadelphia Regional Technical Meeting of the American Iron and Steel Institute, Dec. 3, 1953.

How Heat-Treatment Affects Alloy Steels

This is the fourth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

There are in general five different forms of heat-treatment used with hot-rolled alloy steel. These treatments modify the mechanical properties of the steel to suit the end use. Basically, heat-treating may be defined as an operation or series of operations involving the heating and cooling of steel in the solid state to develop the required properties.

The five forms of treatment mentioned above, as applied to constructional alloy steels, are discussed in the following paragraphs:

(1) QUENCHING AND TEMPERING usually consists of three successive operations: (a) heating the steel above the critical range, so that it approaches a uniform solid solution; (b) hardening the steel by quenching it in oil or water; and (c) tempering the steel by reheating it to a point below the critical range in order to effect the proper combination of strength and ductility.

(2) NORMALIZING is a form of treatment in which the steel is heated to a predetermined temperature above the critical range, after which it is cooled slowly to below that range in still air. The purpose of normalizing is to promote uniformity of structure and to alter mechanical properties.

(3) ANNEALING consists of heating the steel to a point at or near the critical range, then cooling at a predetermined rate. Annealing is used to develop softness in steel, to improve machinability, to reduce stresses, to improve or restore ductility, and to modify other properties.

(4) SPHEROIDIZE-ANNEALING is the prolonged heating of steel at an appropriate temperature, followed by slow cooling to produce a globular condition of the carbide. This treatment produces a structure which may be desirable for machining, cold-forming or cold-drawing, or for the effect it will have on subsequent heat-treatment.

(5) STRESS-RELIEVING is the process of reducing internal stresses by heating the steel to a temperature below the critical range and holding for a time interval sufficient to equalize the temperature throughout the piece. The object of this treatment is to restore the elastic properties of the steel, or to reduce stresses that may have been induced by machining, cold-working, or welding.

Bethlehem metallurgists have had long experience in all methods of heat-treating. They understand the possibilities and limitations of each method with respect to various alloy steels. These men will be glad to give advice or help you with any problems concerning heat-treatment. Always feel free to ask for their services.

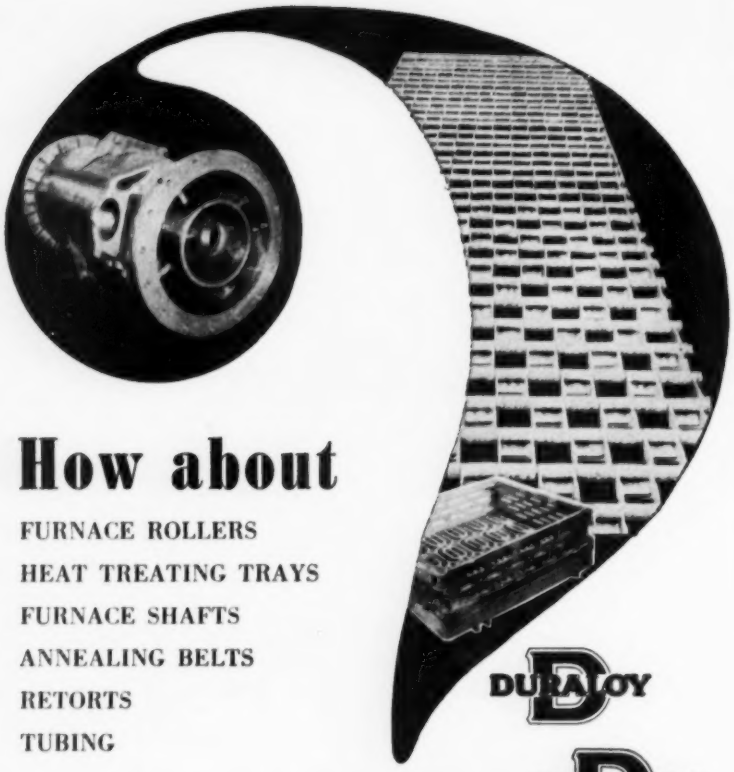
And call on Bethlehem, too, for the full range of AISI standard alloy steels, as well as special-analysis steels and all carbon grades. We can meet your needs promptly.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM ALLOY STEELS

BETHLEHEM STEEL



How about

FURNACE ROLLERS
HEAT TREATING TRAYS
FURNACE SHAFTS
ANNEALING BELTS
RETORTS
TUBING

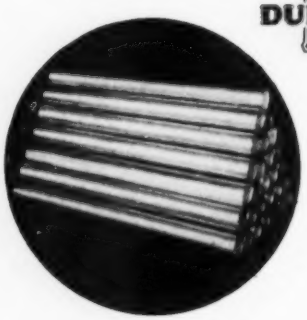
DURALOY

DURASPUN

Which are
Heat Resistant

Corrosion Resistant

Abrasion Resistant



When ready to order, how about checking with us here at DURALOY? For more than thirty years we have specialized in high-alloy castings. In fact, we were among the first to produce static castings and the first to produce centrifugal castings. We are old hands at producing castings alloyed to fit each specific requirement and to finish them to any extent desired.

Melt, castings and finishing are carefully controlled and quality tested by our staff of metallurgists, chemists, X-ray and gamma-ray technicians. If you would like more preliminary information, send for Bulletin No. 3150-G.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.

Large Forgings . . .

(Continued from p. 148)

He rightly states, "the subjects of heat treatment, inspection and testing and other phases of the subject all merit separate discussions", but he is to be congratulated upon having dealt with so much in a comparatively small space.

The paper also includes some interesting statistics relating the total tonnage of forgings with total manufacture of steel for all purposes. Although the annual tonnage of open die forgings is comparatively small, their value and importance are great. Furthermore, it is not always remembered that an immense amount of investigation and experience has preceded the ability to make the kind of heavy forgings that – to quote Mr. Schaefer – justify "the confidence we feel in our product and the reason for that confidence".

H. H. BURTON

Techniques Refined for Arc Welding Nodular Irons*

ARC WELDING as a method of fabrication, repair and salvage of nodular (or ductile) iron castings is commercially practicable, providing a few basic precautions are observed. Considerable experience has been gained with coated austenitic nickel-iron electrodes – in particular "Ni-Rod 55", a 60-40 Ni-Fe core wire, coated with a carboniferous limespar flux. Other available electrodes differ primarily in the coating.

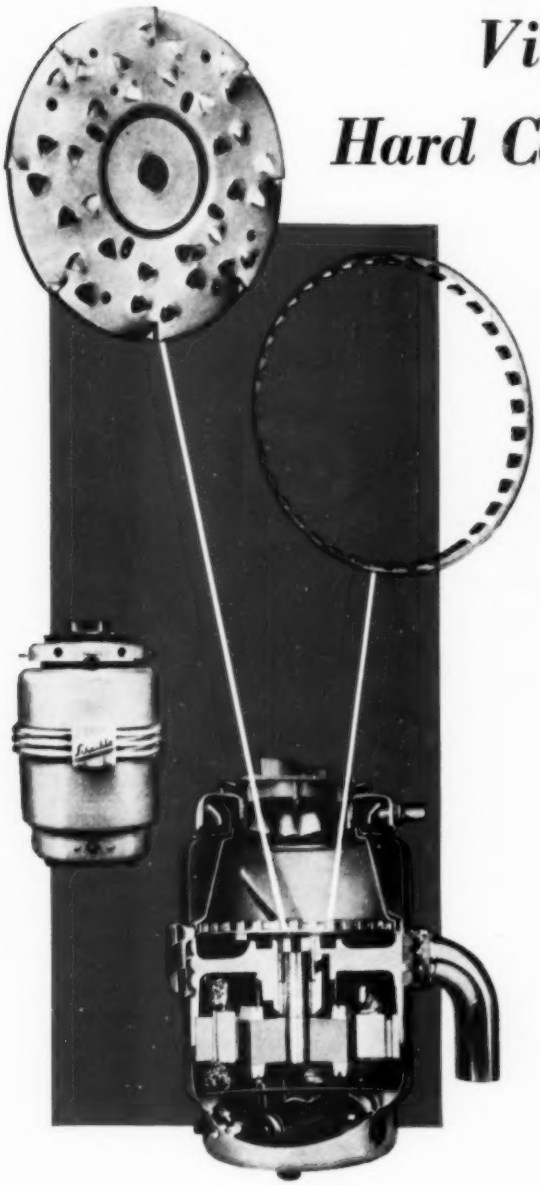
In general, the higher the Mn and Ni contents of the cast material (and hence the weld hardenability), the less latitude there is in welding and the greater the need for preheat. Increase in weld hardenability

(Continued on p. 152)

*Digest of "Joining of Ductile Iron by Several Arc Welding Methods", by T. E. Kihlgren and H. C. Waugh, in *Welding Journal*, October 1953, p. 947; also from a discussion by T. E. Kihlgren of a paper, "Welding Metallurgy of Nodular Cast Iron", by E. E. Hucke and H. Udin, presented at the annual fall meeting of the American Welding Society in Cleveland, Oct. 19-23, 1953. (See p. 108 in this issue for further comment on the subject.)

The Schaible Story:

Vital Grinder Parts Hard Cased in Park-Kase 5-C



The new grinding principle of the Schaible Food-Waste Disposer is shown here. Particle discharge size is positively controlled by reduction grating through horizontal milling action, impingement cutting and clipping. The snag-toothed cutter and the clip ring used in this process require hardness and toughness. Park-Kase 5-C gives these tools the necessary hard case for years of efficient, dependable service.

Fifth in a series of advertisements describing Park processes on the job

Maximum Hardness at LESS COST for Schaible Cutter Disc and Clip Ring!

At the Schaible Company the grinding elements used in the production of the Schaible Food-Waste Disposer are precision hard cased with water soluble Park-Kase 5-C. Result: a higher hardness which means longer life and greater efficiency for these fast-action grinding teeth . . . *in less time and at less cost*. Here's why:

The rapid and uniform case depth of Park-Kase 5-C liquid carburizer means fast, reproducible cases which can be held to close limits for accurate, dependable work at temperatures up to 1700°F. Park-Kase 5-C produces eutectoid carbon cases which contain enough nitrogen to be file hard after oil quenching. High penetration rates and ease of cleaning are combined for ideal carburizing conditions. Inexpensive, simple, and trouble-free . . . Park-Kase 5-C lowers production costs.

- Lightness of Original Charge and Reduction of Salt Drag-out Keeps Costs Down.
- Does Not Foam While Operating.
- Water Solubility Means Time Saved on Oil Quenched Work.
- Needs No Special Complicated Mixing Procedures.

Complete details of the Park-Kase 5-C Carburizing process covering all phases of its operations are described in a technical bulletin available by mailing the attached coupon.

• Liquid and Solid Carburizers • Cyanide, Neutral, and High Speed Steel Salts • Coke • Lead Pot Carbon • Charcoal • No Carb • Carbon Preventer • Quenching and Tempering Oils • Drawing Salts • Metal Cleaners • Kold-Grip Polishing Wheel Cement

Park

PARK CHEMICAL CO.

8074 Military Avenue • Detroit 4, Michigan

Send Free Bulletin Describing Park-Kase 5-C

Name_____ Position_____

Company_____

Address_____

City_____ State_____

Welding Nodular Iron

(Continued from p. 150)

is reflected in greater machining difficulties in the heat-affected zone.

Phosphorus also must be controlled to avoid weld cracking, 0.10% being a maximum in welding plates with Ni-Fe electrodes or filler wire, and 0.05% maximum advisable where mild steel electrodes are involved. A nominal cast plate composition, giving a good combination of mechanical properties and weldability is: 3.50% C, 2.40% Si, 0.25% Mn, 0.70% Ni, 0.05% P max., 0.06% Mg.

For maximum welding response, ductile iron castings should be welded in the annealed (FHT) condition, comprising normally a 1-hr. heat at 1650° F., slow cooling to 1275° F., holding for 5 hr. and finally air cooling. This treatment assures the greatest freedom from fusion line cracks and best machining qualities in as-welded joints.

Average tensile data on joints in ½ to 1-in. thick ductile iron made with Ni-Fe electrodes and attesting the improvement in ductility following heat treatment, as well as joint strength close to that of the base metal, are shown in the tabulation above.

Plate Condition	Postweld*	Yield At 0.2% Offset	Tensile Strength	Elong. in 2 in.
As cast	AW	56,900	65,000	1.5%
As cast	FHT	45,900	63,800	10
As cast	FT	47,700	61,600	5
Annealed (FHT)	AW	44,500	60,600	9
Annealed (FHT)	FHT	42,500	60,500	12
Annealed (FHT)	FT	44,700	60,700	12

*AW: as welded. FHT: 1650° F. for 1 hr., furnace cool to 1275° F., hold for 5 hr., air cool. FT: 1275° F. for 5 hr., air cool.

Test welds were made with 5/32-in. electrodes at about 130 to 140 amp., d.c., reverse polarity. A double-V, 70° included angle, a ¼-in. root gap and copper backing were employed, with the welds quite severely restrained by four C-clamps. They were not peened.

Peening is often practiced to reduce stresses in the joint. If done, it should be by repeated moderate blows rather than a few heavy blows. A ½ to ¾-in. rounded peening tool or a ball-peen hammer is recommended.

Preheating also is helpful in obtaining a good bead contour and a good wash. The amount of metal to be deposited and severity of subsequent service determine the degree of preheat. Cold castings should be warmed to at least 200° F.; where high stresses are to be expected 300 to 350° F. may be adequate, although 550 to 600° F. is preferable.

Ni-Fe electrodes yield weld metal with Vickers hardness of about 160 in the absence of plate dilution; as-welded hardness when diluted by the base metal is considerably higher. In general, the weld metal of a multilayer, single-V butt joint in ½-in. plate will show about 225 Vickers. In single-layer welds, the hardness can be kept at a satisfactory low level simply by using moderately heavy beads.

The weld structure contains graph-

(Continued on p. 154)

MITCHELL-BRADFORD

. . . a name synonymous with Quality and Service which guarantees continued and trouble-free production.

Technical literature and bulletins on any of the following products available on request.

BLACK MAGIC Black Finish for Steel
BLACK MAGIC Black Finish for Zinc
BLACK MAGIC Black Finish for Cadmium
BLACK MAGIC S.S. Black Finish for stainless steels, cast and malleable irons
MAGIC NEUT Neutralizer after Black Oxide finishing
WITCH DIP REGULAR Semi-drying wax finish
WITCH DIP #2 Gloss, semi-gloss, dull, hard drying wax finish
WITCH OIL Water displacing, rust preventative
WITCH OIL "B" Heavy duty, water displacing, rust preventative
PIK-AIDE Pickling addition agent
QUICK PIK Dry acid
COMPOSITION D Rust preventative, solvent, detergent, cleaner, rancidity retardent
MAGIC DRY A plating necessity
MAGICLENE #2 Rust preventative, rust remover, cleaner and paint base
SOAK CLEANERS For all metals
ELECTROLYTIC CLEANERS For all metals
SOLVENT CLEANERS For removing heavy soils
PROCESSING TANK EQUIPMENT Automatic Temperature Controls
COMPLETE LINE of Heat Treating Salts, Carburizing, Tempering, Neutral, Nitriding, etc.

★

Mitchell-Bradford

The MITCHELL-BRADFORD CHEMICAL CO.
2443 Main St. Stratford, Conn.

QUALITY PRODUCTS OF CHEMICAL RESEARCH



It's *easy* to produce and maintain *high vacuum* in big systems

We do it every day—design and manufacture vacuum furnaces, dehydration systems, vacuum stills, pumping systems for particle accelerators, and other large high vacuum units.

The high vacuum metallurgical furnace illustrated above is typical of the large units *CVC* is designing and manufacturing.

CVC's ever expanding line of standard high vacuum pumps, valves, gauges, and accessories offers unlimited possibilities for assembling efficient, high capacity gas handling systems. Our highly skilled designing and manufacturing facilities stand ready to engineer and build completely integrated high vacuum systems.

So, if a large high vacuum system can help you improve a product or process it will pay you to talk to us—***Consolidated Vacuum Corporation, Rochester 3, N. Y.*** (A subsidiary of Consolidated Engineering Corporation, Pasadena, Calif.)

CVC

Consolidated Vacuum Corporation

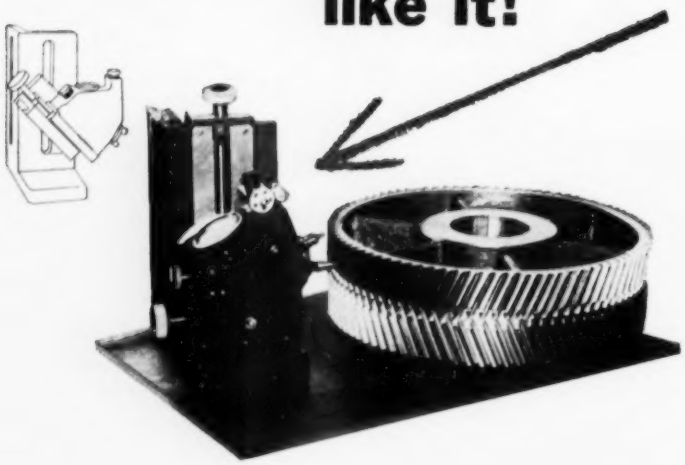
Rochester 3, N. Y.

formerly DPi Vacuum Equipment Dept.

designers and manufacturers of high vacuum equipment

SALES OFFICES: PALO ALTO, CALIF. • CHICAGO, ILL. • CAMDEN, N. J. • NEW YORK, N. Y.

there's nothing like it!



penetrascope
metal hardness tester

No clamps needed with this new, semi-portable Multiple-Angle Metal Hardness Tester. For a combination of accuracy and versatility, there is nothing like it in American industry today.

The Multiple-Angle Penetrascope illustrated above was developed for testing the many parts and places inaccessible when clamps are used — gear teeth roots and large bearing races, for example. The Penetrascope is movably mounted on a magnetic stand holding the unit firmly to a ferrous surface on which the object to be tested is also set securely. Adaptability is obtained by angling the stand on the ferrous surface, by angling the Penetrascope on its stand, and by adjusting the height of the Penetrascope on the stand.

For more accessible work, the basic Penetrascope is available with a variety of C-Clamps and Magnetic Clamps. The Penetrascope employs a 136° pyramidal diamond indenter and loads from 1 kg. to 30 kg. Extremely accurate results are obtained in the range 16 to 800/1000 D.P.H., with excellent comparative results up to 1500 D.P.H.

PENETRASCOPE "PLUS" VALUES

1. **Accurate** — Extremely accurate from 16 to 800/1000 D.P.H.
2. **Versatile** — Capable of conventional and multiple-angle testing of large or small pieces; pieces can be tested at site.
3. **Portable** — Basic unit weighs about 18 pounds net; extra weight of semi-portable multiple-angle unit is more than offset by its versatility.
4. **Minimum marring** — light loads permit minute impressions, considered by many to be non-destructive.

Send for our booklet on the Penetrascope today.

C. TENNANT, SONS & CO., OF NEW YORK
100 PARK AVENUE, NEW YORK 17, N.Y., U.S.A.
TELEPHONE OREGON 9-1300

Welding Nodular Iron

(Continued from p. 152)

ite in an austenitic matrix, with some carbides present in cored crystals. Annealing rejects more graphite and decomposes any iron carbide which may be present. A carbide flash is always present at the frontier of fusion, with the adjacent heat-affected zone showing considerable martensite. Multilayer welding exerts an annealing effect adjacent to at least a portion of the previous weld layer, serving to temper the martensite and, depending upon temperature, to decompose some of the primary carbides, yielding ferrite and small spheroids of graphite.

The weld metal offers no serious problem in machining, except possibly under conditions of heavy plate dilution. Machinability is determined by the condition of the plate in the heat-affected zone. The carbide flash at the frontier of fusion is quite narrow, usually 0.005 to 0.015 in. Over-all width of the heat-affected zone varies, but is usually about 0.10 in.

Joints made in plate annealed before welding naturally are more readily machined than those in as-cast material. A full anneal after welding provides good machinability over wide variations in composition, prior plate condition and welding procedure. Postweld anneal at 1275° F. improves machinability, while a simple torch anneal at about 1000° F. for 10 to 15 min. may be adequate in a ½-in. section. Carbide-tipped tools are superior to toolsteel, particularly where a substantial hard zone exists.

Ductile iron has been arc welded successfully with the Ni-Fe electrodes to a number of dissimilar metals – mild steel, Type 216 stainless, Monel metal, nickel and Inconel. Joining ductile iron to mild steel is even more easy than welding the material to itself, since the heat-affected zone of the mild steel remains soft and can yield to relieve internal stresses. A variety of applications of this technique have been reported.

Field experience in welding ductile iron with steel electrodes is limited, although laboratory tests suggest a mild steel electrode of the

(Continued on p. 156)

an ACCO product

Wilson "Rockwell"* Hardness Testers

New Motorized WILSON "ROCKWELL"* Hardness Tester with SET-O-MATIC* Gauge



SET-O-MATIC* DIAL GAUGE

• Eliminates human error. Operator merely applies minor load and taps depressor bar. No setting of dial to zero.

OTHER FEATURES

- **Major load applied under dash pot control**
- **Major load removed by motor**
- **Illuminated Dial Gauge**
- **Illuminated Penetrator**

Eliminates Operations... Increases Tests per Hour

• All you have to do with the Model Y WILSON "ROCKWELL" Motorized Hardness Tester is apply the minor load and tap the major load depressor bar. The machine does everything else automatically. The cycle of Major Load operation may be less than 2 seconds.

The Model Y WILSON "ROCKWELL" Motorized Hardness Tester permits great savings in time which will reduce your hardness testing costs. Yet there is no sacrifice of Wilson's high standard of accuracy.

The utter simplicity of setting the SET-O-MATIC* dial gauge eliminates human error. The operator does not have to set the dial. The large pointer is automatically brought to "SET" position when the minor load is applied.

The Model Y Motorized WILSON "ROCKWELL" Hardness Tester is in production and orders are being accepted for early delivery. Write today for descriptive literature and prices on the Model Y or other WILSON "ROCKWELL" hardness testers.

** Trade Marks*

ACCO
Wilson Mechanical Instrument Division
AMERICAN CHAIN & CABLE
230-F Park Avenue, New York 17, N. Y.

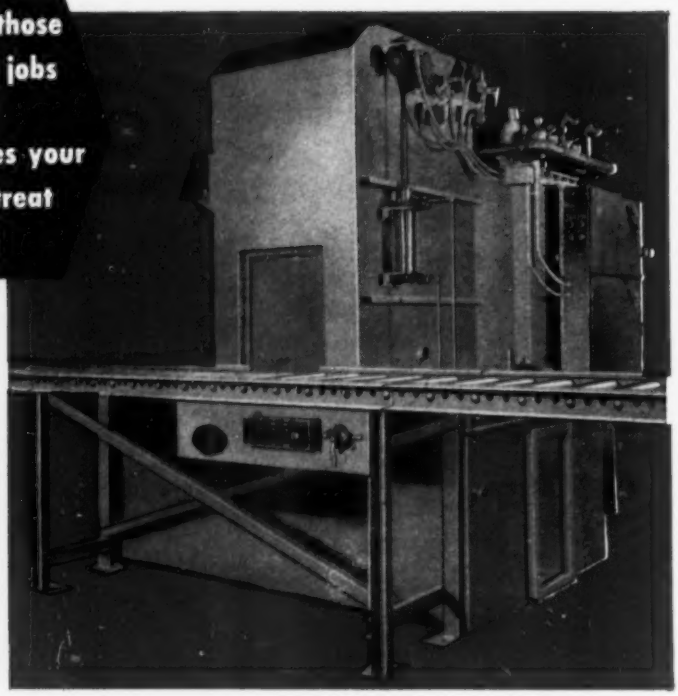
plus BRALES and TUKON

DOW'S "J-800" MODEL

Licks those tough jobs

•

Slashes your heat treat costs!



"NO-GAP" OPERATION—A batch type furnace with less than 30 seconds between loads. Work chamber is never exposed to air. Loading is accomplished while slow cooling or quenching a previous load.

GREATER PRODUCTION—Actual field operation has proven conclusively that the Dow Model J-800 will easily bring 800 pounds from room temperature to 1500° F in less than one hour.

COMPACT CONSTRUCTION—Occupies floor area of only 7'10" x 14'4" giving maximum production for minimum floor space.

VERSATILITY—Ideal for carbonitriding, gas carburizing, clean hardening and carbon restoration. Hot oil quenching and atmosphere cooling equipment available.

EXCLUSIVE FEATURES—High capacity fan combined with heat capacitor assures uniform case depth throughout each load • Forced circulation of quench oil assures uniform hardness with minimum distortion • Sealed quench tank gives cleaner stock—minimizes fire hazard.

DOW FURNACE COMPANY

First WITH MECHANIZED, BATCH-TYPE, CONTROLLED ATMOSPHERE FURNACES

12045 Woodbine Ave., Detroit 28, Mich.

Phone: KEnwood 2-9100

Welding Nodular Iron

(Continued from p. 154)

low-hydrogen type may be suitable. Castings should be relatively low in Mn and Ni (perhaps 0.35% and 0.70%, respectively) with a maximum of 0.05% P. They should be fully annealed prior to welding. A preheat of 600° F. minimizes cracking tendencies.

Successful arc welding, on a production scale, of ductile Ni-Resist to Type 347 stainless steel, and of ductile iron to "NAX" low-alloy high-tensile steel, using A.I.S.I. Type 431 and 310 stainless steel electrodes, respectively, has been reported by J. Sohn, W. Boam and H. Fisk, in *Welding Journal*, September 1953, p. 823. The weldments were component parts of jet aircraft engines and were described as operating satisfactorily over long periods of time, in a field where quality standards are high and service conditions are rugged.

Further systematic study is needed to evaluate the advantages and limitations of the various arc welding processes on ductile iron, as well as to establish preferred casting compositions for maximum welding response and to develop improved welding procedures.

A. H. Allen

British Tests on Welded Pressure Vessels*

British Welding Research Association has been experimenting on full-sized pressure vessels in an attempt to secure data for a rational design of end closures and openings. Only the initial stages of this work are discussed in the article here under review.

It is almost always necessary to measure stress on both the inside and the outside surfaces of the vessel; measurements on one side only can be highly misleading. It is also important to remember that commercial vessels or pipes differ from the idealized structures of the mathematician, since slight irregularities

(Continued on p. 158)

*Digest of "Researches on Welded Pressure Vessels and Pipelines", by Nicol Gross, *British Welding Journal*, April 1954, p. 149.

How To Solve Corrosion Problems



PROBLEM: Protecting a preheater from corrosive attack during periodic contact with hydrochloric acid, trichlor benzene, and other chlorine compounds at 300 deg. F.

REMEDY: Complete lining with HASTELLOY alloy C 11-gage sheet.

RESULT: The vessel has given four years' service and is still going strong.



PROBLEM: Valving sulphur-laden flue gas at 800 deg. F. and 300 psi.

REMEDY: A ⅛-in. layer of HASTELLOY alloy B was applied to seats and seating surfaces.

RESULT: The valves gave over four years' service despite the corrosive conditions.

Free: Money-saving jobs like these are described in detail in the monthly magazine HAYNES ALLOYS DIGEST. To receive a copy regularly, write Editor, HAYNES ALLOYS DIGEST, Room 308, 30 East 42nd Street, New York 17, New York.

HASTELLOY *alloys*

Trade-Mark

Nickel-base, corrosion-resistant alloys available as sheet, plate, bar stock, welding rod, welded tubing and pipe, cast pipe and pipe fittings, sand and precision-investment castings.

"Hastelloy" is a registered trade-mark of Union Carbide and Carbon Corporation.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

Welded Pressure Vessels

(Continued from p. 156)

are unavoidable. Thus, even in a straight tube, variations of thickness and out-of-round must be expected, and the latter superimposes on the stresses due to pressure in the ideal cylinder some very high bending stresses.

Electric resistance wire strain gages are best suited for strain measurements inside pressure vessels. So much has been written in recent years about the various techniques for using them that one is apt to forget their simplicity. Their functioning depends on the fact that when a piece of wire is stretched, it will change its electrical resistance, and the latter is easily and precisely measured.

When strain gages are attached to the inside of a vessel, they must be well insulated from the testing medium – usually water. Success in high-pressure water (up to 7000 psi.) depends on the tedious operation of applying and waterproofing the strain gages, as well as insuring adequate insulation of the leads to the indicator. Leads from the strain gages are taken to an indicator, manually operated if there are up to 40 to 60 measuring stations, or to an automatic scanning and recording device if the particular problem being investigated requires more measuring points.

Stress Probing – A simplified method, known as stress probing, has been devised to speed up the measurements.

Stress probing consists of subjecting a vessel to slow pulsations of pressure while a mechanical gage is pressed against the surface; the deflection of the pointer in rhythm with the pressure pulsations is a measure of the strain induced. Obviously this gives no direct information about the stress *inside* the vessel.

Stress probing requires an apparatus for cyclic loadings of constant range and a suitable device for measuring the changes of induced strain. As regards the latter, a Swedish instrument* of small base length (0.12 to 0.40 in.) is useful; it records the change of helix angle of a length of perforated, twisted metal strip. In our tests, this instrument was held in place by a spring-loaded arm attached by a magnetic clamp to the test specimens, the arm being so designed that readings at many stations could be taken with the magnet in the same position.

Limitations – Engineers have so readily adopted strain gages because they work in terms of the physical reality of the structure, instead of a mathematical idealization. Unfortunately a tendency has arisen to believe that this method can provide a full answer to all design problems. They do provide data with which the designer can judge the behavior of a structure when it is subjected to operating loads. Experience with similar welded structures in service, however, is then needed for the determination of "safety factors" which must cover those contingencies about which strain gages can offer no information.

Measurements *in the elastic range only* do not tell the full story. Stress peaks will be reduced by localized plastic flow. Thus there is no known immediate relationship between the initial stress concentrations and the real danger of bursting in the vicinity of a given discontinuity.

Before the engineer can form a true picture he must obtain other information from statistical study of known failures in service. Information on service failures is usually difficult to obtain; therefore laboratory work, to be really significant,

(Continued on p. 160)

*See description by R. Gunnert in *Arcos*, 1951, p. 3027.



ROLOCK

FABRICATED HEAT AND CORROSION RESISTANT ALLOYS

BASKET SERVICE...

THAT'S HARD TO BEAT

at WILLYS MOTORS, inc.

ALUMINUM FORGE DIVISION

Shown in action is one of 24 similar stainless steel etch baskets designed and fabricated by Rolock Incorporated. Dimensions are 6′ x 3′ x 16½″; load is 500 lbs. of aluminum forgings . . . thru the following 6-cycle operations:

A. Acid pickle, 10% sulphuric acid, 3% chromic acid solution at 160° F.
B. Cold water rinse.
C. Etch in 10%-15% caustic solution at 160°-180° F.
D. Cold water rinse.
E. Bright dip in 10% sulphuric acid, 3% chromic acid solution at 160° F.
F. Hot water rinse.

EACH BASKET has been subjected to an average of 125 cycles per month for more than SIX YEARS . . . and they're still going strong . . . after a total of about 10,000 cycles. THAT IS SERVICE!



- **This Case History is another demonstration of the value of Rolock engineered-to-the-job, fabricated-welded design and construction of containers for handling metal parts.**
- **Extended service life reduces costs materially, improves the work, cuts time. Rolock design and construction raises the ratio of load to basket weight, thus again reducing costs.**
- **Rolock engineers welcome your inquiries for baskets, trays, racks, crates, fixtures, retorts, muffles, vessels, kettles, etc., for heat and corrosion resistant applications.**
- **Send your tough problems to us for solution. We welcome the challenge.**

Offices in: PHILADELPHIA, CLEVELAND, DETROIT, HOUSTON, CHICAGO, ST. LOUIS, LOS ANGELES, MINNEAPOLIS, PITTSBURGH

ROLOCK INC. · 1222 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

6RL54A



PAY YOURSELF for heat-treating small tools with a



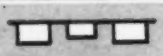
Waltz





Start "paying yourself" the difference between the low operating costs of a Waltz furnace and the charges for outside service. In addition to this money savings you can eliminate (1) materials-handling expenses involved in getting tools to and from the outside service, (2) production delays caused by waiting for outside service.

The Waltz small tool heat-treating "package" is a compact unit designed for convenient positioning in your shop (furnace sections equipped with casters). Set-up includes preheat furnace, high-heat furnace and quench tanks.

furnace-quench tanks-furnace (corner) positioning	furnace-furnace-quench-tanks (side-by-side) positioning	furnace-quench tanks-furnace (side-by-side) positioning
		

Furnaces have temperature ranges permitting treatment of all high-speed steels. Standard designs or special heat-treating furnaces are available, built to use many different fuels. Write today for comprehensive bulletin to Dept. W.

Waltz FURNACE COMPANY
SYMMES STREET • CINCINNATI, OHIO

Welded Pressure Vessels

(Continued from p. 158)

requires that tests be carried to destruction of full-scale (or at least large-scale) specimens.

In the absence of complementary information from these two sources, engineers are compelled to accept an intelligent approximation instead of a solution. Strain gages can do no more than achieve this result.

E. E. T.

A. E. C. Program . . .

(Continued from p. 97)

scale-up over the small one running out in Idaho is from 1400 to 62,500 kw. of heat, and from 170 up to 15,000 kw. of electric power.

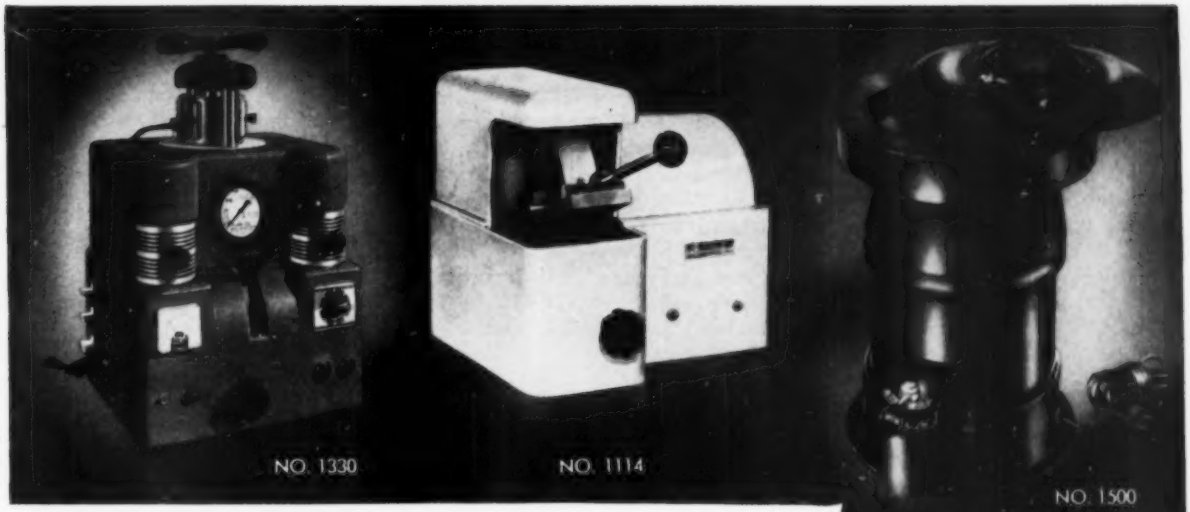
Our third step will attempt to use the boiling of water as a method of heat extraction, hoping to put steam directly into the turbines. Present plans call for 20,000 kw. of heat and 5000 kw. of electric power.

The fourth reactor is a larger version of the homogeneous reactor and again it will be an intermediate step. Present specifications call for only 3000 kw. of heat from this reactor compared to 1000 in the present experiment at Oak Ridge. The next step, already planned, calls for 65,000 kw. of heat in a homogeneous reactor which will breed U^{233} in a surrounding blanket of thorium.

The fifth experimental reactor will use sodium-potassium alloy as coolant and graphite as a moderator. The hot coolant will not boil so it will be a low-pressure furnace generating about 20,000 kw. of heat – which will be wasted, at least at the start.*

In addition to these new proposals, we shall continue several other programs already under way. These include the intermediate submarine reactor near Schenectady, and the development of a reactor to propel aircraft.

*On March 25, Commissioner Zuckert said that the A.E.C. entered into a contract with North American Aviation whereby the latter would house the experiment, provide the facilities, and operate the project, contributing $2,500,000 of the total $10,000,000 expected to be spent in the next two years. He also said "there is another project that we hope to launch very soon in cooperation with the Army Engineers. This project is a package nuclear power plant for use in remote areas such as the arctic wastes."



NEW MODERN, PRECISION BUILT MACHINES FOR THE METALLURGICAL LABORATORY ARE DESIGNED BY BUEHLER LTD.

NO. 1330 SPEED PRESS provides speedy and practical preparation of mounted specimens in either opaque bakelite or the crystal clear plastic compounds. Stainless steel mold assemblies produce 1", 1¼", and 1½" mountings.

NO. 1114 SPECIMEN CUTTER with sludge trap, for table top mounting. Total enclosed cutting assembly. Specimen holder and adjustable clamps on swing arm with operating handle. Enclosed ½ HP ball bearing motor.

NO. 1500 STANDARD POLISHER produces accurately polished specimens with speed and ease. 8" diameter bronze wheel mounted to ¼ HP ball bearing motor. Speeds of 550 & 1150 r.p.m.

NO. 1700 NEW AB ELECTRO POLISHER produces scratch-free specimens in a fraction of the time usually required for polishing. Speed with dependable results is obtained with both ferrous and non-ferrous samples.

NO. 1251 DUO-BELT WET SURFACER is the most modern apparatus for the flat preparation of metallographic specimens. Two belts of different grits travel at speeds of 1600 & 3200 ft.p.m.

NO. 1511-2 DELUXE POLISHING APPARATUS has convenience of desk-top height. Wash bowl, two 12" swing spouts, two 8" removable wheels . . . one standard 1500 F and one low speed 1505-2 F polishing heads.

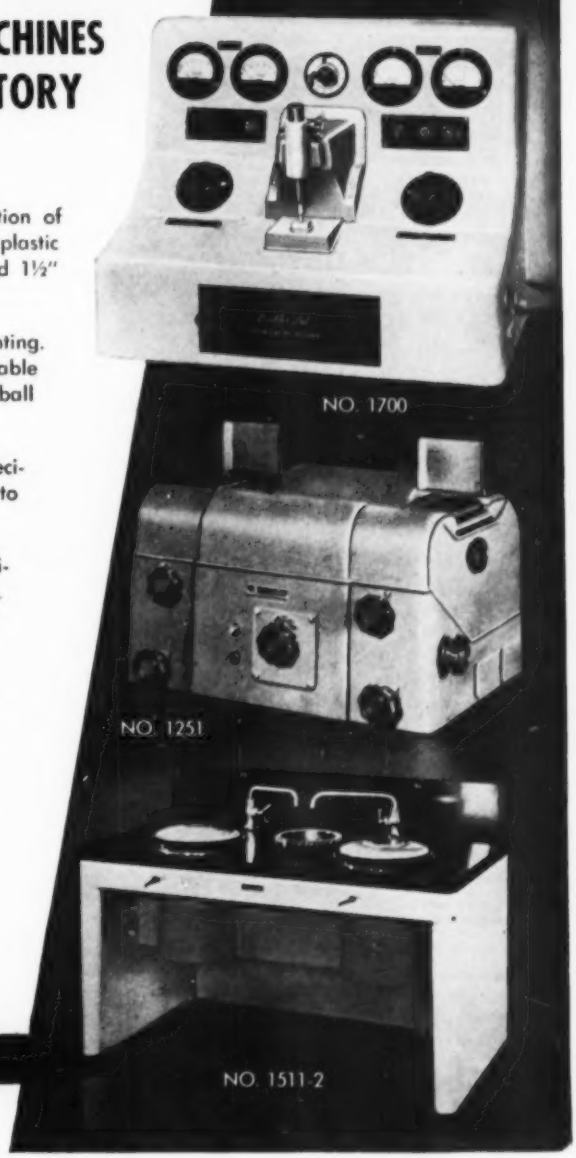
SEND FOR CATALOG OF OUR COMPLETE LINE.



Buehler Ltd.

METALLURGICAL APPARATUS

2120 GREENWOOD STREET
EVANSTON, ILLINOIS, U.S.A.



Cathodic Vacuum Etching

(Continued from p. 112)

Stains and Artifacts

A substantial portion of the energy is converted to heat and if this is not dissipated properly the cathode gets very hot. Aluminum can be melted easily, and grain growth induced in zirconium. If the temperature goes much above that used in our work, several undesirable effects occur. Stainless steel becomes heat tinted; a uranium surface quickly turns black, obscuring any structure which may have been developed.

The "temperature" of the sample referred to above is that of the bulk of the material rather than the surface. Some theoretical models for the mechanism of energy transfer at the surface of the cathode postulate that very high temperatures exist at the surface on a scale of atomic dimensions. Although very steep temperature gradients may exist there, no detrimental effects on the microstructure have been observed.

Another temperature-dependent artifact was observed with silicon bronze: If the sample is etched in the usual manner, but the temperature is allowed to drop below the dew point before exposure to the atmosphere, water condenses on the surface and staining results.

Redeposition of part of the dislodged material may occur during cathodic vacuum etching. A deviation from the usual procedure while etching a cupronickel sample resulted in an observable deposit similar to one type described by Feitknecht. The sample was dull and appeared to be covered with myriad small dark spots whose number was much greater on the cupronickel side of the interface. By using the electron microscope it was established that the spots were low, rather flat projections about 2.5 microns in diameter. The sample had been cooled for 11 min. before the power was applied; consequently the sample was etched at lower temperatures than usual. When similar samples were etched employing the 3-min. cooling procedure, no deposit was observed.

All of the materials mentioned in this article excepting aluminum have been successfully etched on zirconium fittings. When pure aluminum and aluminum alloys were etched on zirconium fittings there was a noticeable layer of redeposited material on the resulting surfaces. A similar difficulty was encountered when etching zirconium samples on aluminum fittings, but to a lesser degree. Redeposition was eliminated in both these instances by using cathode fittings made of the same type of metal as the sample. Other materials tried were found to etch equally well on both types of fittings.

Summary – The time and extra care formerly required for cathodic vacuum etching have been reduced to a level which makes a practicable routine of this nonchemical means of etching metals. The speed and other desirable characteristics are derived primarily from the cooled cathode. Etching times are of the order of 1 to 3 min. compared with 1 to 3 hr. in previous techniques. With this procedure the ion current density is held constant during etching

(Continued on p. 164)



The Production-WISE
ROLL FORMING MACHINE



ARDCOR
MODEL 1-F

Spindle Diameter	1½"
Roll Diameter	4¼" to 7"
Horizontal Distance Between Spindles	12"
Roll Space on Standard Machine	10"
Capacity Max.	.072

ADAPTABILITY—Ardcor Standard Forming Machines feature "unit construction" for each stand. Thus production changes are easily and quickly made. With this feature, any length base can be furnished to accommodate additional units as required.

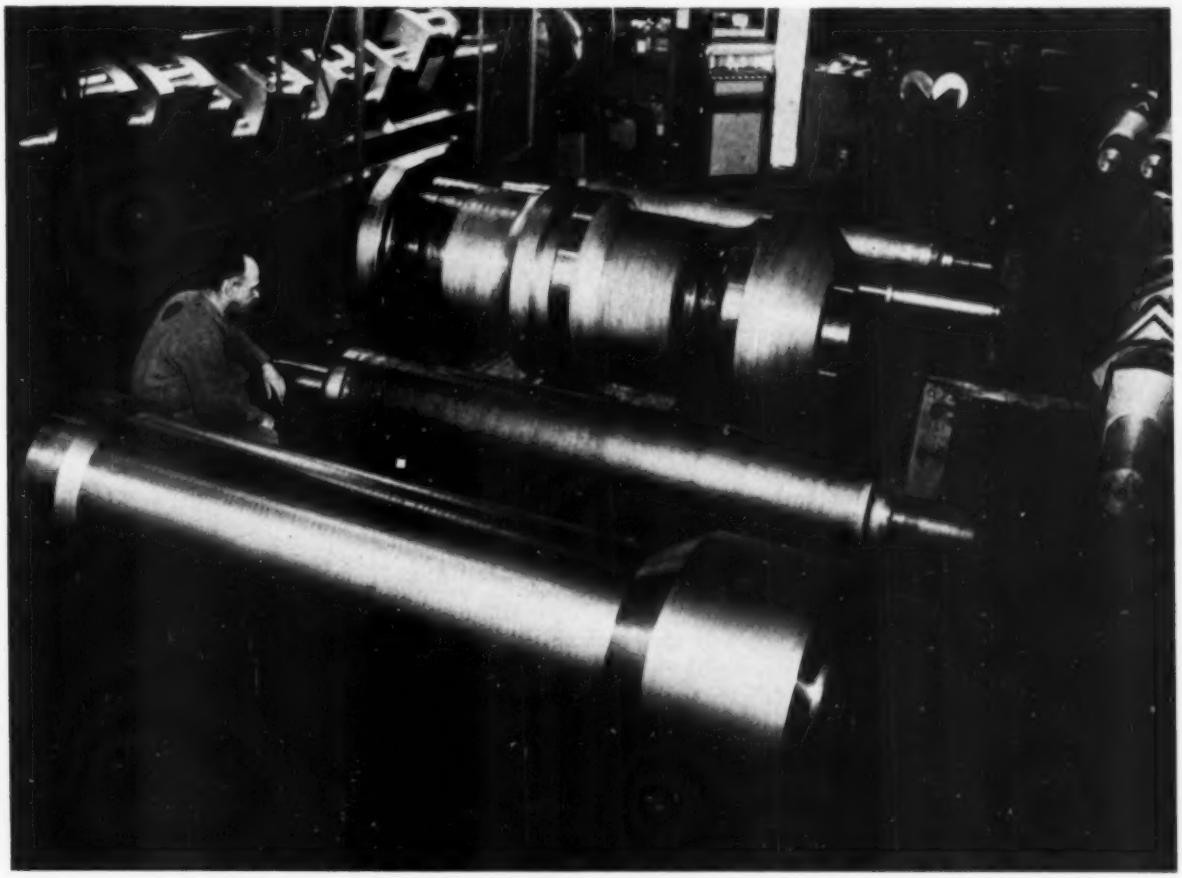
Ardcor Roll Forming machines embody the precision, accuracy and stability found only in the highest grade machine tools. In addition, Ardcor offers a completely engineered installation—cradle reels, roll forming machines, roller dies, flying cut-off fixtures, etc.—from one qualified source.

Likely as not your special shapes can be ideally handled by a standard Ardcor machine. Your inquiry is invited—without obligation.

Also Standard Machines up to 4½" Spindle Diameter.

American ROLLER DIE CORPORATION
29551 Clayton • Wickliffe, Ohio

Versatility at NATIONAL FORGE



Here is a ram, two flame-hardened rolls and a cylinder. In the left background is a crankshaft being machined.

This shows in a small part the large variety of forgings produced at National Forge. Small or large, alloy or carbon, heat-treated or annealed, rough or finished, each forged machine part is carefully produced to meet the customer's specification.

Besides a regular line of forgings, National Forge has additional facilities for contract machining and can produce single parts, sub-assemblies or complete machines.

This versatility offers you a service beyond the regular forge shop. Perhaps you have some problem in a forging or a machine component which might be solved at National Forge.

Write, wire, phone or visit us; we are always ready to be of service!

National Forge
AND ORDNANCE COMPANY
Irvine, Warren County, Pennsylvania

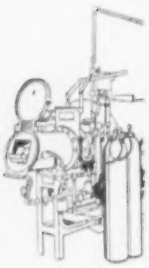
STEEL MAKERS ☆ FORGESMITHS
HEAT TREATERS ☆ MACHINISTS

How To Cut Costs in Metal Treating!

...Use BARRETT® BRAND Anhydrous Ammonia

–and you have the most economical source of dis-associated hydrogen and nitrogen for metallurgical uses. 6,750 cubic feet of Hydrogen and Nitrogen from a single 150 lb. cylinder! And you don't have to stock up heavily–our coast-to-coast delivery service will give you *fast* delivery on 150, 100 and 50-lb. cylinders.

Check the many jobs Barrett Ammonia can do so well–then order today!



Do You Use Anhydrous Ammonia for *These* Important Jobs?

- Protective atmosphere for bright annealing, brazing and powder metallurgy.
- Nitriding of alloy steels and carbonitriding (Dry Cyaniding) for treatment of steel.
- Case hardening of iron and steel with case depths up to 0.025 inches.
- Sintering of metal powder compacts.
- Augmenting corrosion–resistance treating for aluminum, magnesium, other light metals.
- As a solvent in making electrolytes for electrolytic recovery of salts.

GET THIS VALUABLE HELP!

Technicians specially trained in the use of Anhydrous Ammonia for the above and other metallurgical uses are ready to help you. No obligation. Call or write today! Also–valuable handbook available on the use and economical handling of Ammonia. Request it.



Look for the green cap!

First in Ammonia Since 1890

NITROGEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Cathodic Vacuum Etching

(Continued from p. 162)

and time is the controlling variable.

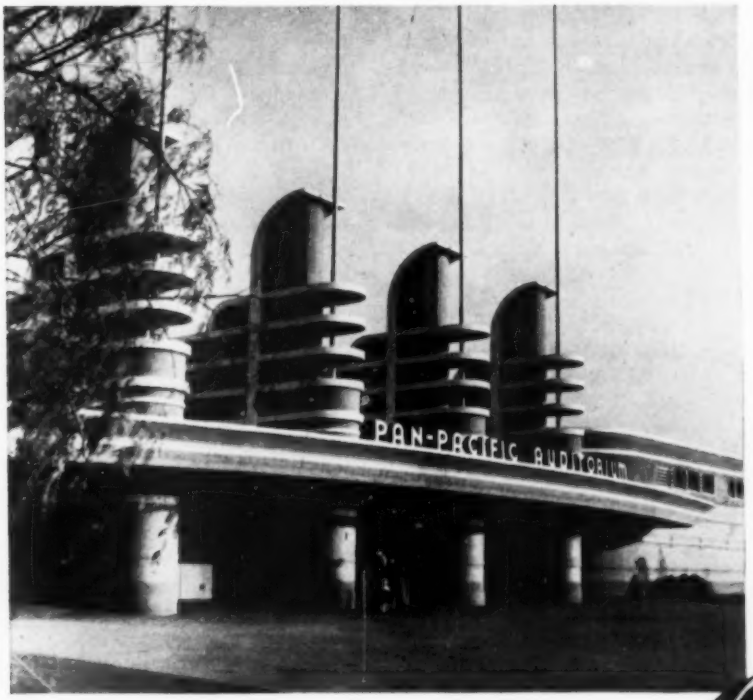
In general, one set of electrical and pressure conditions in a system of fixed geometry was found to be satisfactory for the etching of a variety of materials cut in various cross-sectional sizes and shapes; diverse materials could be etched in spite of differences in chemical activity, types of structures and inclusions, mode of oxide formation and etching rates. The structures developed using this procedure were clean, free from artifacts and displayed good contrast in bright-field illumination.

In addition to this wide applicability in general metallography, cathodic vacuum etching is useful for etching dissimilar metal couples, cemented carbides, and composites of metals and nonmetallics.

References

1. "Procedures in Experimental Physics", by J. Strong, Prentice-Hall, Inc., New York, 1938.
2. "Fundamental Processes of Electrical Discharge in Gases", by L. B. Loeb, John Wiley and Sons, Inc., New York, 1939.
3. "Gaseous Conductors, Theory and Engineering Applications", by J. D. Cobine, McGraw-Hill Book Co., Inc., New York, 1941.
4. "Theory of Cathode Sputtering in Low Voltage Gaseous Discharges", by C. H. Townes, *Physical Review*, Vol. 65, 1944, p. 219 to 227.
5. "Uber den Angriff von Krystalled durch Kanalstrahlin", by W. Feitknecht, *Helvetica Chemical Acta*, Vol. 7, 1924, p. 825 to 848.
6. "Note on Cathodic Disintegration as Method of Etching Specimens for Metallography", by C. S. Smith, *Journal* of the Institute of Metals, Vol. 38, 1927, p. 133 to 136.
7. "Cathodic Vacuum Etching of Metals", by D. M. McCutcheon, *Journal of Applied Physics*, Vol. 20, April 1949, p. 414 to 415.
8. "Cathodic Vacuum Etching of Metals", by D. M. McCutcheon and W. Pahl, *Metal Progress*, Vol. 56, Nov. 1949, p. 674 to 679.
9. "Cathodic Sputtering for Micro Diffusion Studies", by F. Fisher and C. E. Weber, *Journal of Applied Physics*, Vol. 23, February 1952, p. 181 to 183.

'55 WESTERN METAL EXPOSITION and CONGRESS



Pan-Pacific Auditorium
Los Angeles
MARCH 28—APRIL 1, 1955



Grown Great Thru Service!

9th of a distinguished and successful series of Western Metal Expositions . . . the 1955 event promises even greater rewards . . . for exhibitors and visitors alike, than have ever before been achieved in these time-proved events! Months away . . . interest has sharpened and activity has mounted to indicate a record-breaking number of products and services displayed before record-breaking audiences . . . historic proof of the outstanding significance of these great Metal Shows!

Pan-Pacific Auditorium
LOS ANGELES
best-known and most accessible exhibit hall in the west . . . will again be the scene of the Exposition.

Ambassador Hotel
OFFICIAL HEADQUARTERS
for The Western Metal congress—make reservations now for March 28-April 1, 1955.

THE AMERICAN SOCIETY FOR METALS
7301 Euclid Avenue · Cleveland 3, Ohio
W. H. EISENMAN, Managing Director *Chester L. Wells, Assistant Director*

Screening Test for Cast Stainless Steels*

THESE TESTS were reported from the Duriron Co., Inc., Dayton, Ohio. They represent further significant investigations of the applicability of the method originally proposed by M. A. Streicher in the article, "Screening Stainless Steels From the 240-Hour Nitric Acid Test by Electrolytic Etching in Oxalic Acid", published in *ASTM Bulletin*, February 1953, p. 35.

The method was to electrolytically etch a polished surface in 10% oxalic acid and view the etched surface at magnifications from 250 to 500. The appearance of the etched surface determined whether the sample was free from intergranular carbide precipitation or there was sufficient attack to warrant the time and expense necessary for the 240-hr. nitric acid test.

Since it is desirable to adapt the rapid screening test to cast as well as wrought stainless steels, the laboratories of the Duriron Co. started work on the cast compositions. As a result of these tests it can be definitely concluded that the cast alloys designated by Alloy Casting Institute as CN-7M, CF-8, and CF-8M can be screened by the foregoing technique.

The samples were polished through No. 000 emery paper and then made the anode of an electrolytic cell with a 10% (by weight) oxalic acid electrolyte. Etching was conducted with a current density of 1 amp. per sq.cm. for 1½ min. Introductory work was conducted on the wrought stainless steels, particularly Types 304 and 316. The microstructures common to wrought stainless steels after various heat treatments were easily distinguishable. Data from the boiling nitric acid test were obtained from duplicate samples to verify results. The test is not so critical as to render it unpredictable. Once it was clearly established that the technique was correct, tests were started on the cast grades.

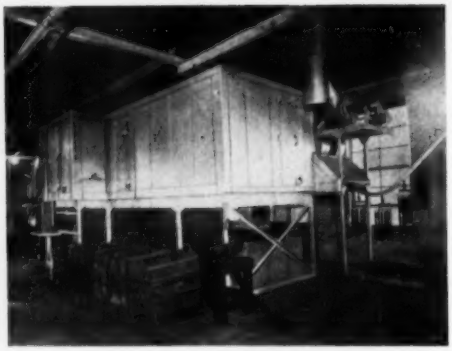
The alloy CN-7M is austenitic and characterized by a relatively large grain structure. If it receives correct solution treatment (water quenched from 2000° F.) its grain boundaries appear as a series of small discontinuous pools or globules of carbide. Such structures have a corrosion rate in nitric acid of 0.0008 to 0.0015 in. per month. When the alloy is badly sensitized (precipitated), the grain boundaries will appear ditched and the material will have a corrosion rate in nitric acid of 0.0244 in. per month – which is greatly in excess of the maximum 0.0025 in. per month allowed for this alloy. When the grain boundaries appear as a thin continuous black line, the test is considered inconclusive and the steel should be subjected to the standard test in boiling 65% nitric acid. Selective attack of small areas within the grains themselves should not be considered detrimental. The criterion for this steel is the presence of ditching at the grain boundaries.

(Continued on p. 168)

*Digest of "Screening Cast Stainless Steels by Electrolytic Etching in Oxalic Acid", by G. W. Jackson and W. A. Luce, *ASTM Bulletin*, January 1954, p. 71.

GET 4 Savings WITH YOUNG BROTHERS OVENS for HEAT TREATING

Savings in...
TIME
MATERIAL
SPACE
and FUEL



Continuous-Type Stress Relieving Oven

Only in Young Brothers Ovens, do you get the specially engineered features that provide maximum savings *and* improved results. You reduce production time . . . prevent loss of materials . . . get better quality work when you use Young Brothers Ovens.

Their exclusive advantages have been developed through more than 50 years of specialized oven experience. Thousands of successful installations in leading firms have produced highly profitable results.

For sincere, practical advice on your heat treating problems, without obligation, ask for a Young Brothers engineer, or write for Bulletin 14-T, today.

Estab. 1896

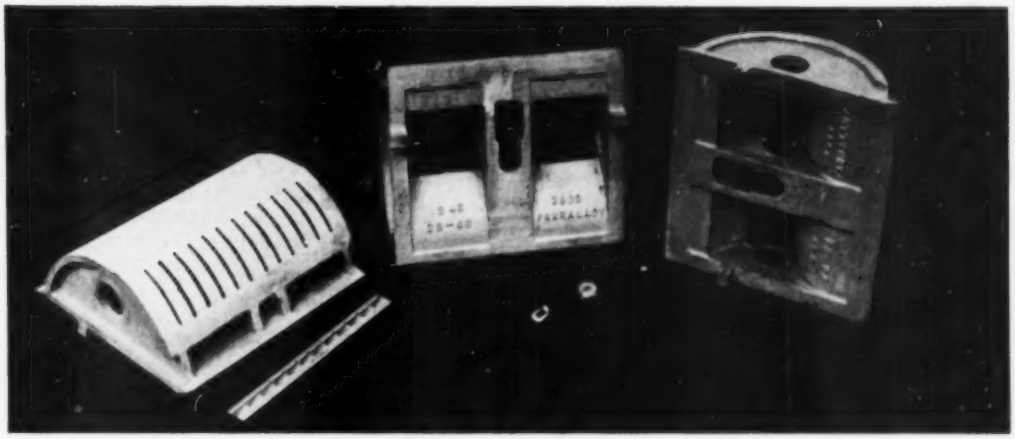
YOUNG BROTHERS COMPANY
1829 Columbus Road Cleveland 13, Ohio

THERE'S HEAT THERE'S FAHRALLOY

WHERE THERE'S HEAT THERE'S FAHRALLOY

FAHRALLOY...

versatility means better heat and corrosion resisting alloy products for you



Recuperator Liner for Cement Mill Cooler



Retort for Pit Type Carburizer

DURING the more than 20 years that Fahralloy has been producing heat and corrosion resisting alloy castings for industry, versatility has been a keynote of the company's operations . . . versatility in design, in size, in composition to meet each individual need. Fahralloy thinking has always been in terms of solving heat and corrosion problems. That's why Fahralloy castings assure better service and longer life. When you have a problem that involves the toughest of high temperature service conditions, you can have complete confidence that you will find the solution at Fahralloy.

•

CLARE CHARRON • 209 Curtis Building • Trinity 5-7633
DETROIT Area Representative

•



THE FAHRALLOY CO.

150th & Lexington Ave. — Harvey, Illinois
In Canada — Fahralloy Canada, Ltd., Orillia, Ontario

WHERE THERE'S HEAT THERE'S FAHRALLOY WHERE THERE'S HEAT THERE'S



Daddy, you keep calling Superman "Superdie". (SUPERDIE® is Daddy's favorite die steel).

COLUMBIA TOOL STEEL COMPANY • CHICAGO HEIGHTS, ILL.

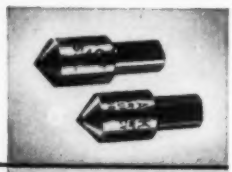
Producers of fine tool steels — All types immediately available through Sales Offices, Warehouses and Representatives in Principal Cities.

TOOL COLUMBIA STEELS

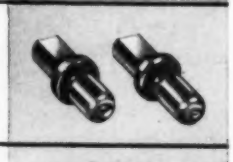
Call on CLARK

for All Your "Rockwell Testing" Needs

CLARK Diamond Cone Penetrators are exactly right for your "Rockwell" hardness tester, whether or not it bears the CLARK name. Every step in their manufacture, from careful diamond selection to expert lapping, leads to a precision product that will give you precision results. Yet CLARK Diamond Penetrators cost surprisingly little.



CLARK Steel Ball Penetrators, for accurate "Rockwell testing" of unhardened steel, cast iron, brass, bronze, and similar materials, are available in all standard sizes.



CLARK Test Blocks, in various hardness grades, provide a quick, sure, and simple method of checking the accuracy of your "Rockwell" type hardness tester.



Write today for descriptions and prices.

CLARK INSTRUMENT, INC.
10202 Ford Road • Dearborn, Mich., U.S.A.

CLARK

Screening Test . . .

(Continued from p. 166)

The CF-8 and CF-8M steels are not normally completely austenitic and may show appreciable ferritic areas in the structure. The presence of complete ditching of grain boundaries or heavy etching of interconnecting ferrite stringers indicates the necessity for further testing by the standard 240-hr. nitric acid method. As with the CN-7M alloy, the presence of scattered pitting in CF-8 and CF-8M alloys is characteristic and of no consequence in the screening operation.

To check the reliability of this test method, a number of specimens from consecutive routine foundry heats made over a period of months were subjected to the procedure. All heats showed structures which would be acceptable under the above standards. These samples were also spot checked with the boiling 65% nitric acid test.

All nitric acid tests were well within prescribed limits and the screening tests were verified. This illustrates that with proper control the method can be reliably applied to the screening of cast stainless alloys CN-7M, CF-8 and CF-8M.

R. L. ANDERSON

Comparison of Costs in Openhearth and Electric Furnace Shops*

A THOROUGH analysis of steelmaking costs in openhearth and electric furnace shops is given in this report. It is stated that production costs in making steel are made up of terms which fall into two major categories: "cost above", or normal overhead, and cost of metallics in the furnace charge.

Since the term "cost above" in

(Continued on p. 170)

*Second of a three-part digest of "Comparative Economics of Openhearth and Electric Furnaces for Production of Low-Carbon Steel"; a report prepared by S. L. Case, D. D. Moore, C. E. Sims and R. J. Lund, Battelle Memorial Institute, of a study sponsored by the Electric Furnace Survey Group and Bituminous Coal Research, Inc. Published by Bituminous Coal Research, Inc., Pittsburgh; price $10. (First part published in June issue.)



Twin Kemp Atmos Gas Generators Give This Steel Producer Absolute Atmosphere Control

Preventing oxidation and discoloration during the annealing of cold strip steel is the assignment of two Kemp Model 6-MR Atmos Gas Generators installed at Thomas Strip Division of Pittsburgh Steel. The picture shows Fred Michaels, Turn Foreman, observing the test burner on the panel of the controlled atmosphere producer.

Fueled with natural gas, these units supply uniform atmospheric gas within the annealing furnaces . . . deliver exact qualitative analysis regardless of load demand. Delivering up to 6,000 cfh, the battery of Kemp Generators assures protection against oxidation and discoloring of steel in process.

Kemp Units "Do Far Better Job"

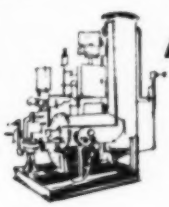
Division management states that the Kemp Generators are doing a far better job than the generating equipment they replaced. Purity of the gas is very good by actual analysis . . . equipment capacity increased . . . maintenance and labor costs reduced . . . product quality improved by the much closer atmospheric control made possible by Kemp.

Kemp Can Help You

If you have a controlled atmosphere problem, Kemp can help you. Every Kemp Atmos Generator is engineered for fast-starting, easy operation . . . delivers a chemically-clean, controlled atmosphere at specific analysis, without fluctuations regardless of demand. For convenience, safety, and dependability—specify KEMP. A Kemp engineer will gladly discuss your own specific problem without obligation.

Write: C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.

KEMP OF BALTIMORE



ATMOS GAS GENERATORS

ADSORPTIVE DRYERS • SINGEING EQUIPMENT
IMMERSION MELTING POTS
CARBURETORS • BURNERS • FIRE CHECKS

Cost Comparison . . .

(Continued from p. 168)

steel melting operations has been a subject of great interest among steel men for many years, the very thorough discussion of this factor in the report should be of considerable interest. In steelmaking the process cost above may be divided into two major groups.

1. Items that are directly related to tonnage of ingots produced. These items are: fuel (oil, tar, coke-oven, natural or producer gas for the openhearth process, or electric power and electrodes for the electric furnace process); molds and stools; fluxes; ladle refractories, stoppers, nozzles, and similar supplies.

2. Items that constitute the relatively stable overhead costs and are not directly proportional to the tonnage of steel produced per hour. These include: furnace refractories; production labor; furnace repairs; maintenance labor; indirect labor; supplies, tools, lubricants; yard switching; water and utilities; general expense; fixed charges.

In comparing the melting cost of the electric furnace with that of the openhearth, it will be obvious that the two main factors are definitely related to the comparative cost of openhearth fuel as compared to the cost of electric power and electrodes. Most other items of overhead cost listed under the second group are common to both operations and in general are quite similar.

The term cost as used in the preceding paragraphs does not include the fixed charges, which are a summation of interest, taxes and amortization of plant cost. In this report these fixed charges are calculated on the basis of 12% of the total capital cost at the 1952 level of prices for raw material and labor. According to present methods of accounting, 12% may be too small, since it is based on the old concept of amortizing the plant in about 20 years. The trend today is for a more rapid

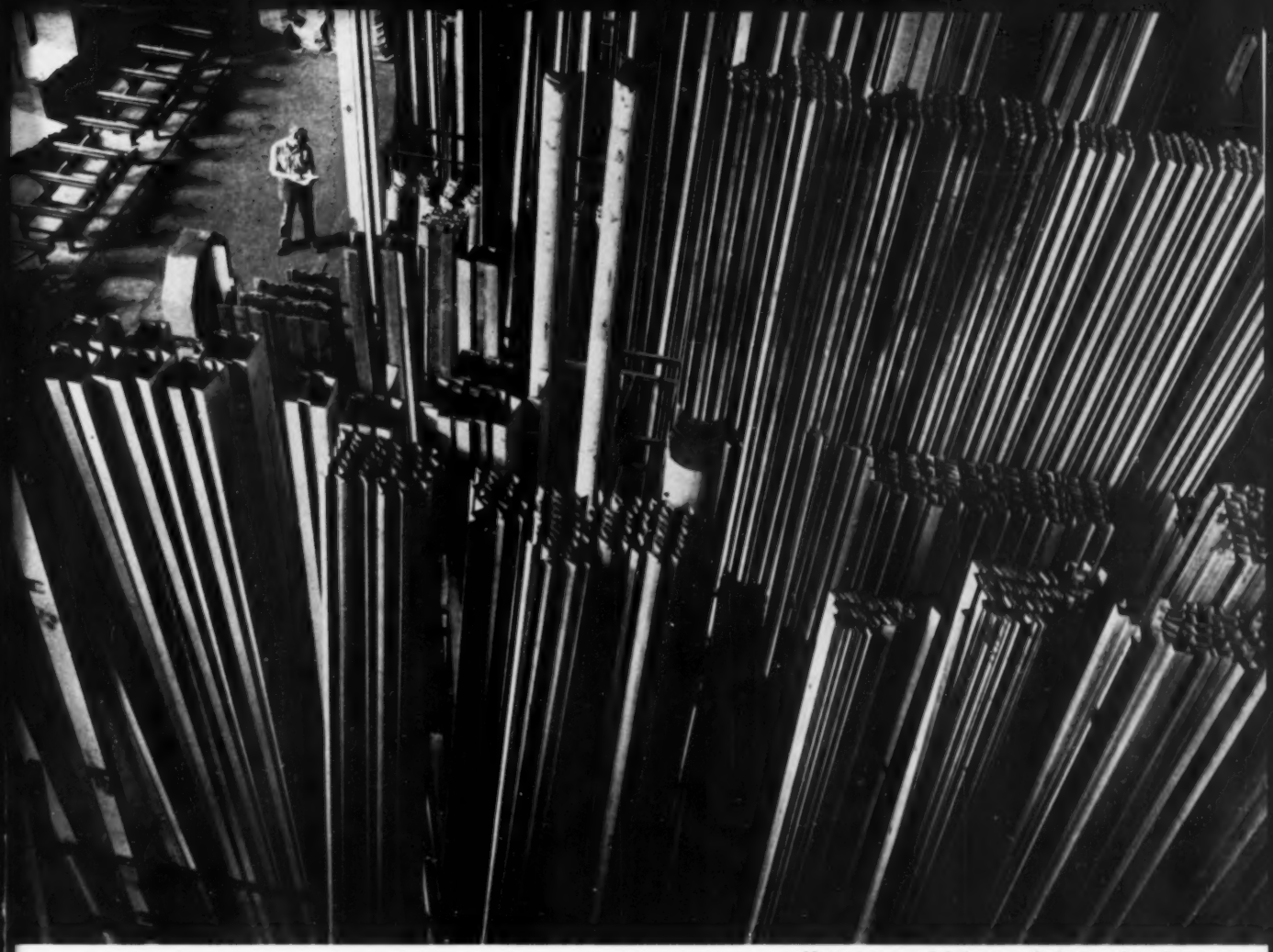
(Continued on p. 172)

Table II — Estimated 1952 "Cost Above" per Ton of Ingots in an Openhearth Shop*

	Cold Metal	50% Hot Metal
Fuel oil	$ 2.76	$ 1.98
Fluxes	0.69	0.50
Furnace refractories	0.70	0.70
Ladle refractories	0.15	0.15
Furnace repairs	1.60	1.50
Molds and stools	0.65	0.65
Production labor	2.00	1.60
Maintenance labor and materials	0.70	0.55
Oxygen	. . .	0.20
Supplies, tools, lubricants	0.20	0.20
Water, steam, electric power	0.35	0.30
Yard switching	0.20	0.20
Slag disposal	0.35	0.30
Indirect labor (Supervision, metallurgical, clerical)	0.20	0.20
Employee benefits	0.35	0.30
General expense (overhead)	0.45	0.40
Total	$11.35	$9.73
Fixed charges (Interest, taxes, and amortization)	3.88	3.20
Total†	$15.23	$12.93

*Eight 200-ton furnaces providing 1,000,000 tons annual ingot capacity.
†Including fixed charges based on 1952 capital costs.



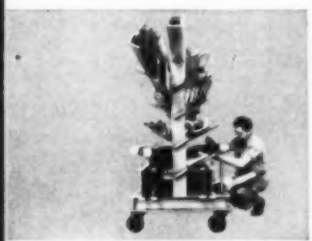


Magnesium extruded shapes ready for immediate shipment.

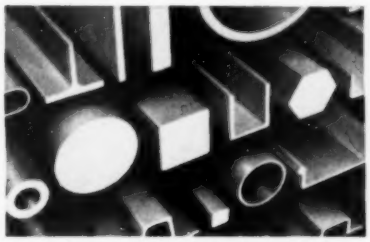
a new look at Magnesium!

NEW AVAILABILITY... SHAPES AND LENGTHS NEVER BEFORE EXTRUDED

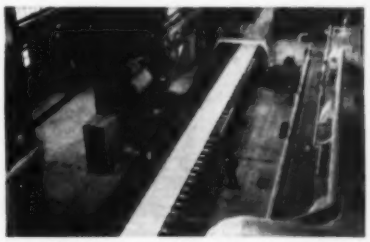
Designers and cost-conscious production men have found the answer to their problems in many applications with magnesium extrusions—now produced by new Dow facilities. Standard and special shapes, bars, rods and tubing—all are readily available in alloys which save weight, add strength, cut costs. Get information on magnesium from your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Midland, Michigan.



Inspector checking special extruded shapes offered in a wide variety of alloys and sizes.



Magnesium bars, rods, shapes and tubing. Available in diameters or cross sections up to 10 inches.



World's first 84-inch magnesium coil mill now rolls sheet and plate in greater lengths and widths.



This coil of magnesium sheet started through the 84-inch coil mill as a one-ton rolling ingot.

you can depend on DOW MAGNESIUM

DOW

MISCO EXPERIENCE is your INSURANCE



In

ANNEALING HOODS
CARBURIZING BOXES
MALLEABLEIZING BASKETS

AND OTHER

HEAT-TREATING CONTAINERS

MIS-COR DESIGNS

ADD **STRENGTH**

REDUCE **WEIGHT**

MISCO FABRICATORS, INC.

Designers, Builders, Fabricators of Heat Resisting Alloy and Stainless Steel Equipment

1999 GUOIN STREET • DETROIT 7, MICHIGAN

TELEPHONE LORAIN 7-1545

Cost Comparison . . .

(Continued from p. 170)

amortization. The latter method would be very favorable to the electric furnace plant because of its lower total investment cost.

Again basing the comparison on a plant of one million tons annual capacity, Table II shows the overhead factor per ton of ingots in an openhearth plant, and Table III gives similar figures for an electric furnace shop of the same capacity. In these cost-above figures, fuel oil is estimated at 60c per million Btu. and electric power at 9 mills per kw-hr. The table for each type of shop shows the total estimated overhead for a 100% cold metal charge and a 50% hot metal charge. To each cost-above figure are added the fixed charges on the plant, and the total gives the complete cost-above value for the four different conditions of operation. The significant difference in these overhead costs is that the cost of power for the electric furnace

(Continued on p. 176)

Table III – Estimated 1952 "Cost Above" per Ton of Ingots in an Electric Furnace Shop*

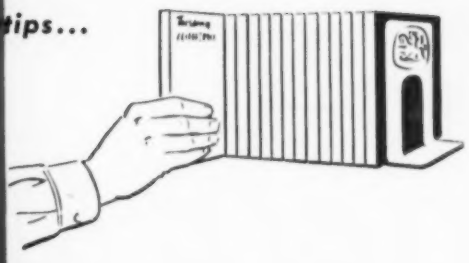
	Cold Metal	50% Hot Metal
Power	$ 4.70	$ 4.25
Electrodes	2.16	1.80
Fluxes	0.62	0;67
Furnace refractories	0.50	0.45
Ladle refractories	0.15	0.15
Furnace repairs	1.30	1.20
Molds and stools	0.85	0.85
Production labor	1.35	1.25
Maintenance labor and materials	0.65	0.55
Oxygen	0.28	0.28
Supplies, tools, lubricants	0.20	0.20
Water and utilities	0.35	0.35
Yard switching	0.20	0.20
Slag disposal	0.20	0.20
Indirect labor (Supervision, metallurgical, clerical)	0.20	0.20
Employee benefits	0.25	0.23
General expense (overhead)	0.40	0.40
Total	$14.35	$13.23
Fixed charges (Interest, taxes and amortization)	1.91	1.91
Total†	$16.26	$15.14

*Eight 20-ft. furnaces providing 1,000,000 tons annual ingot capacity.

†Including fixed charges based on 1952 capital costs.

Have Technical Knowledge at Your Fingertips...

Send for REYNOLDS READY-REFERENCE HANDBOOK LIBRARY



These valuable handbooks belong on the desk of every engineer, designer and production man. Single copies of any or all of them are free when requested on business letterhead. Otherwise each book is one dollar.



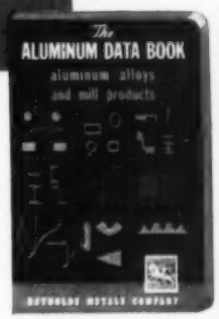
A Complete Index

of all Reynolds Technical Literature and Films on aluminum design and fabrication is also available. **Write Reynolds Metals Company, 2519 South Third Street, Louisville 1, Ky.**

16 MM Color-Sound Films Available, Too

1. SHAPE OF THINGS TO COME (extrusions)
2. TALE OF THE POWDERED PIG (powders and pastes)
3. PIGS AND PROGRESS (mine to finished product)

Instructors in technical schools are also invited to take advantage of these educational aids. Write for details.



ALUMINUM DATA BOOK—196 tables give complete physical, chemical and mechanical properties; availability data, tolerances, definitions, fabrication information . . . 194 pages.



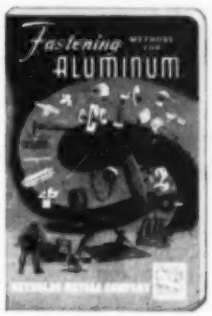
ALUMINUM POWDERS AND PASTES—Describes types of powders and their uses in paints and coatings, pyrotechnics, processing, metallurgy and other applications . . . 64 pages.



DESIGNING WITH ALUMINUM EXTRUSIONS—Explains the basic principles for using extruded aluminum shapes most effectively . . . 138 pages.



ALUMINUM STRUCTURAL DESIGN—Shows how to design original structures with aluminum or convert present designs to aluminum . . . 130 pages.



FASTENING METHODS FOR ALUMINUM—Offers information on mechanical joining and fastening methods, and the advantages of each . . . 136 pages.



FINISHES FOR ALUMINUM—Gives basic data on application and uses for electroplated, mechanical, chemical and organic finishes . . . 124 pages.



ALUMINUM FORMING—Presents accepted practices for bending, forming, and drawing aluminum . . . 152 pages.



MACHINING ALUMINUM ALLOYS—Covers aluminum machining including automatic screw machining . . . 124 pages.



HEAT TREATING ALUMINUM ALLOYS—Explains the theory and procedures for heat treating aluminum alloys . . . 116 pages.



WELDING ALUMINUM—Gives complete data on the welding, brazing and soldering of aluminum . . . 186 pages.

REYNOLDS ALUMINUM

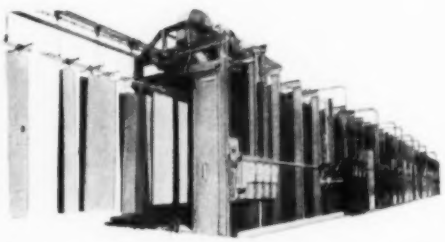
MODERN DESIGN HAS ALUMINUM IN MIND

Here are 6 facts

top men in American about a new service

1 Whatever your industrial heating and processing problem, this new Lindberg service can provide the answer. Its newly created Field-erected Equipment Division can now supply a complete planning, designing, manufacturing and installation service in this field, everything from a single furnace to a complete plant.

2 Lindberg is experienced in this type of service. Over a period of years, under certain conditions, it has been able to provide it to some industries. Now, with new plant and organizational facilities, this experience is available on a broader scale to help answer industrial heating and processing problems in most manufacturing fields.



Vitreous Enameling Furnace field-erected by Lindberg. 180 feet long, electrically heated with 32 zones of control.

3 For many years Lindberg's large technical staff and outstanding scientific laboratories have been recognized as leaders in metallurgical research. This background assures the technical know-how which you can depend on to provide the most effective and economical answer to your industrial heating and processing requirements.

4 Lindberg field-erected contracts are one-firm jobs. Modern plants, up-to-date equipment, experienced personnel and adequate material stocks assure that your installation will be completed on time and will operate with the full effectiveness planned for it.

LINDBERG

Chicago Plant: 2448 West Hubbard Street—Chicago 12, Illinois



Since 1935, Lindberg has been a leader in the development of industrial heating equipment.

*Industry should know offered by Lindberg



Lawrence Remiker



R. A. Hastings



Elmer B. Jones



C. P. Masure

5 A management staff of long experience in this field directs this new Lindberg Division. The men pictured here have spent a collective total of 97 years in planning, designing, erecting and servicing industrial heating and processing equipment. You can afford to depend on their proven abilities in this field.

6 Every contract will have on-the-spot service from one of Lindberg's expert Field Engineers who are located in 22 cities throughout the country. This personal, close-at-hand service follows right through from the original planning to the final installation. Lindberg Branch Offices are located in these cities:

Atlanta	Cleveland	Fairlawn, N. J.
Buffalo	Dallas	Indianapolis
Charlotte, N. C.	Denver	Kalamazoo
Chicago	Detroit	Kansas City
Los Angeles	Pittsburgh	Springfield, Mass.
Milwaukee	San Francisco	St. Louis
New York City	Seattle	Tulsa
Philadelphia		

To get the best possible help with your industrial heating and processing problems just call your nearest Lindberg Branch Office (you'll find the number in the Classified Telephone Directory or in the Trade Book Directories). One of our engineers will be on the job at once.

* *Lindberg Field-erected Division is ready to serve these industries: Aluminum, Automotive, Building Supplies, Copper & Brass, Ceramics & Glass, Plastics, Pulp & Wood Products, Steel and many others.*

ENGINEERING COMPANY

FIELD-ERECTED EQUIPMENT DIVISION

Los Angeles Plant: 11937 So. Regentview Avenue—at Downey, California

Cost Comparison . . .

(Continued from p. 172)

is higher than that of the fuel oil for the openhearth furnace. Most of the other items of fixed cost are quite similar for the two plants. The power cost for an electric furnace using a 50% hot metal charge is estimated at 470 kw-hr. per ton of ingots, a figure which has been confirmed by authors of other papers on electric furnace operations.

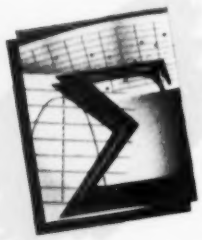
Following these data on overhead costs, the cost of the metals in the charge is analyzed and summarized for the over-all production cost of the two kinds of furnaces. Six tables are presented which combine all the cost elements of operation that have a bearing on the final total cost per net ton of ingots. Using the basis of one million tons of annual ingot capacity, Table IV shows the cost for openhearth and electric furnace operations with a complete cold metal charge and Table V gives a comparison for the two kinds of furnaces operating on a 50% hot metal charge. In these tabulations the prices of scrap, pig iron, iron ore, and ferromanganese were those quoted in *Iron Age* for 1952 with eastern Pennsylvania as the basing point. These prices are $43 per gross ton for steel scrap, $58 per gross ton for basic pig iron, $14 for iron ore, and $225 for 80% ferromanganese. These are fairly close to present quotations and would be logical to apply to any non-integrated plant. The price for basic pig iron, however, is quite out of line with the cost of basic pig iron in an integrated steel plant and the comparative cost must, therefore, be reviewed with this in mind. However, if the electric furnace installation were placed adjacent to the blast furnace in an integrated plant, the cost of pig iron would be the same as for an openhearth plant. On this basis,

(Continued on p. 178)

Table IV—Estimated Production Cost per Ton of Ingots From Cold Charges

Item	Openhearth		Electric Furnace	
	Lb. per Ton	Cost	Lb. per Ton	Cost
Steel scrap @ $43 per gross ton	1668	$32.00	1985	$38.10
Pig iron @ $58 per gross ton	556	14.45	173	4.50
Iron ore (lump) @ $14 per gross ton	24	0.15	50	0.30
80% ferromanganese* @ $335 per gross ton	12	1.20	12	1.20
Total cost of metallics		$47.80		$44.10
"Cost above"		15.23		16.26
Gross cost		$63.03		$60.36
Less credit for 60 lb. of recoverable steel scrap		1.15		1.15
Net production cost per ton of ingots		$61.88		$59.21

*This includes the cost of other deoxidizers such as ferrosilicon and aluminum.



Statistical Quality Control Can Help You

Here is the information that drew capacity attendance to the Philadelphia Chapter's educational course on statistical quality control. Reported in 36 pages, these lectures have a down-to-earth value that you can apply in your job in production, engineering and inspection. Principles of its technique and examples of its use are described clearly and concisely.

Practical Uses of Statistical Quality Control in Metal Industries

- **Units for Measuring Variations in Measurements**
- **Correlation of Test Data**
- **The Practical Uses of Statistical Quality Control in Metallurgical Plants**
- **Some Applications of Statistical Analysis in the Steel Industry**

$1.50

American Society for Metals
7301 Euclid Avenue, Cleveland 3, Ohio

Please enter my order for _____ copies of Practical Uses of Statistical Quality Control in Metal Industries at $1.50 per copy.

Payment enclosed ☐ Bill me ☐ Bill my company ☐

Name _____ Street _____

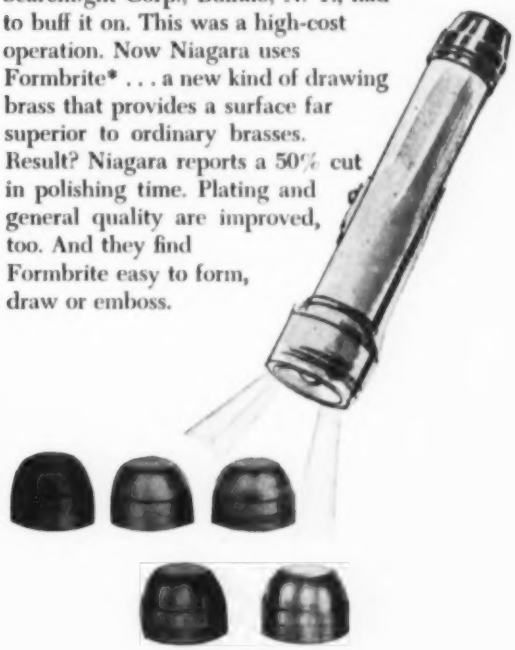
City _____ Zone _____ State _____

ANACONDA METALS AT WORK

The American Brass Company develops a new kind of brass that cuts polishing time 50% for one manufacturer and improves product appearance for another...makes bronzes that extend the life of many metal parts

Spotlight on high luster at low cost

The high luster on these brass flashlight end caps didn't come naturally. Niagara Searchlight Corp., Buffalo, N. Y., had to buff it on. This was a high-cost operation. Now Niagara uses Formbrite* . . . a new kind of drawing brass that provides a surface far superior to ordinary brasses. Result? Niagara reports a 50% cut in polishing time. Plating and general quality are improved, too. And they find Formbrite easy to form, draw or emboss.





Old age insurance...

It's easy to take out. And you pay no premium. All you do is specify ANACONDA Phosphor Bronze for the many components like those shown. Ten alloys are available in seven forms. All are strong and tough. They bear up under constant wear and flexings, periodic stresses, fatigue and corrosion. They resist abrasion . . . conduct heat and electricity well . . . keep their high elasticity. We'll be glad to help you select the Phosphor Bronze Alloy that's just right for your job.

What's in a nameplate?



According to the Arlen Trophy Co., Brooklyn, N. Y., one of the largest trophy and premium manufacturers in the country, the *appearance* of a nameplate often means the difference between landing or losing a sale. But price is important, too. That's why Arlen now makes their nameplates out of Formbrite. It costs no more than ordinary brasses. Yet, because of its superfine grain structure, it polishes to a bright finish in half the time. Formbrite results in harder, stronger, springier, more scratch-resistant products, too.

6-402

Want more information?

Our Technical Department can give you a wealth of information on the properties and applications of Formbrite and Phosphor Bronze. Write to: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*Reg. U. S. Pat. Off.

ANACONDA®

the name to remember in COPPER • BRASS • BRONZE

What do you know about the
Moly-sulfide
A LITTLE DOES A LOT
LUBRICANT?

You may have heard about a highly successful solid-film lubricant which is giving remarkable results in the shop and in the field.

In one 40-page booklet we have collected 154 detailed case-histories describing how difficult lubrication problems have been overcome by molybdenum sulfide. If you wish to be up to date about this solid-film lubricant, fill in the coupon below, attach it to your letterhead and send it off today.

THE LUBRICANT OF MANY USES
Moly-sulfide
A LITTLE DOES A LOT

Climax Molybdenum Company
500 Fifth Avenue
New York City · 36 · N · Y ·



SEND FOR THIS FREE BOOKLET TODAY

Name.....
Position.....
Company.....
Address.....
MP7 MS-3

Cost Comparison . . .

(Continued from p. 176)

the final cost for ingots is definitely comparable.

It is interesting to note in Table IV that the electric furnace plant has an overall ingot cost of $2.67 per ton less than the openhearth plant when a 100% cold scrap charge is used. For smaller plants with lower capacity the differential between an electric and openhearth becomes even more favorable. This result demonstrates that the installation of small isolated electric furnace plants of 250,000 tons to 1,000,000 tons per year is at the present time definitely a cheaper operation than an openhearth plant.

With the use of the 50% hot metal charge, the cost of electric furnace ingots is higher by $1.32 per ton than for the openhearth ingots. This higher cost results because lower thermal electric efficiency is obtained with the hot charge than with the cold. Even so, the difference in cost for the openhearth and the electric furnace charges of 50% hot metal does not seem to be too significant. These final cost figures emphasize that the large electric furnace has become a close competitor of the openhearth, and this does not take cognizance of the better control, better uniformity and usually better performance in service of electric furnace steel as compared to basic openhearth steel. *(To be continued)*

E. C. WRIGHT

Table V—Estimated Production Cost per Ton of Ingots From 50% Hot Metal

ITEM	OPENHEARTH		ELECTRIC FURNACE	
	LB. PER TON	COST	LB. PER TON	COST
Steel scrap @ $43 per gross ton	1126	$21.60	1103	$21.18
Hot metal @ $33 per net ton	1126	18.58	1103	18.20
Iron ore (lump) @ $14 per gross ton	150	0.85	120	0.75
80% ferromangansce* @ $225 per gross ton	12	1.20	12	1.20
Total cost of metallics		$42.23		$41.33
"Cost above"		12.93		15.14
Gross cost		$55.16		$56.47
Less credit for 60 lb. of recoverable steel scrap		1.15		1.15
Net production cost per ton of ingots		$54.01		$55.32

*This includes the cost of other deoxidizers such as ferrosilicon and aluminum.

Properties of Al-Mg-Si Alloys Containing Iron, Manganese or Chromium*

THE COMMERCIAL importance of the heat treatable wrought aluminum-magnesium-silicon alloys motivated this detailed study of the effect which iron, manganese and chromium have on mechanical and corrosion properties.

Earlier investigators have shown that after solution heat treatment, hardening in such alloys is the result of Mg_2Si precipitation. However, when the necessary proportion of magnesium and silicon is present to form Mg_2Si, some silicon remains as a separate phase, the excess magnesium going into solution, and by reducing the maximum solubility of Mg_2Si, results in a reduction of mechanical strength. Thus it is necessary to have excess silicon to obtain highest properties. The age hardening behavior is further complicated by the presence of iron, manganese or chromium.

In this investigation the three series of alloys studied were an iron-

(Continued on p. 180)

*Digest of "The Effect of Iron, Manganese and Chromium on the Properties in Sheet Form of Aluminum Alloys Containing 0.7% Magnesium and 1.0% Silicon", by R. Chadwick, N. B. Muir and H. B. Grainger, *Journal* of the Institute of Metals, Vol. 82, October 1953, p. 75-80.



Invitation to Entrants

9th Metallographic Exhibit

Entries are invited in the 9th Metallographic Exhibit, to be held at the National Metal Exposition in Chicago the week of Nov. 1 through 5, 1954. Entries will be displayed to good advantage and awards will be given for the best micrographs as decided by a committee of judges.

Classifications of Micros

1. Toolsteels and tool materials
2. Stainless steels and heat resisting alloys
3. Other steels and irons, cast or wrought
4. Aluminum, magnesium, beryllium, titanium and their alloys
5. Copper, nickel, zinc, lead and their alloys
6. Metals and alloys not otherwise classified
7. Series showing transitions or changes during processing
8. Welds and other joining methods
9. Surface phenomena
10. Results by unconventional techniques (other than electron micrographs)
11. Slags, inclusions, refractories, cermets

Awards and Other Information

A committee of judges will be appointed by the Metal Congress management which will award a First Prize (a medal and blue ribbon) to the best in each classification. Honorable Mentions will also be awarded (with appropriate medals) to other photographs which, in the opinion of the judges, closely approach the winner in excellence. A Grand Prize, in the form of an engrossed certificate and a money award of $100, will also be awarded the exhibitor whose work is adjudged best in the show, and his exhibit shall become the property of the American Society for Metals for preservation and display in the Society's National headquarters in Cleveland.

All photographs may be retained by the Society for one year and placed in a traveling exhibit to the various Chapters. They will be returned to the owners in May 1955 if so desired.

Rules for Entrants

Work which has appeared in previous metallographic exhibits held by the American Society for Metals is unacceptable. Photographic prints shall be mounted on stiff cardboard; maximum dimensions should be limited to 15 by 22 in. Heavy, solid frames are not permissible because of difficulties in mounting the exhibit. Entries should carry a label on the face of the mount giving:

Classification of entry
Material, etchant, magnification
Any special information as desired

The name, company affiliation and postal address of the exhibitor should be placed on the BACK of the mount.

Transparencies or other items to be viewed by transmitted light must be mounted on light-tight boxes wired for plugging into lighting circuit, and built so they can be fixed to the wall.

Entrants living outside the U.S.A. should send their micrographs by first-class letter mail endorsed "Photo for Exhibition—May be opened for customs inspection." To be acceptable as first-class mail the package should measure no more than 35 x 45 cm. (14 x 18 in.)

Exhibits must be delivered before Oct. 15, 1954, either by prepaid express, registered parcel post or first-class letter mail, addressed to:

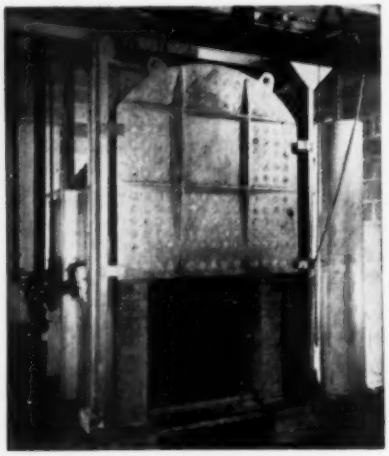
National Metal Exposition
International Amphitheater
43rd and Halsted Sts.
Chicago 9, Ill.

36th National Metal Congress and Exposition

Chicago, Ill. **November 1 to 5, 1954**

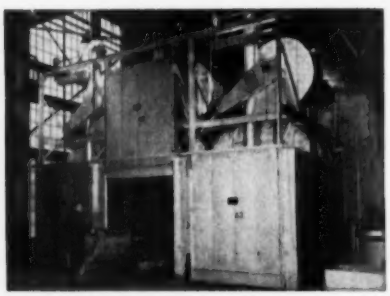
HEAT TREATING FURNACES

UP TO 2000°F. OR MORE



This car-type annealing furnace is an example of the heat treating furnaces designed and engineered by the Carl-Mayer Corp. This particular car bottom furnace was designed for the heat treatment of chain up to 2000°F. at Cleveland Chain & Mfg. Co. We also build furnaces for other uses, including aluminum and magnesium heat treating.

• • •



This battery of three aging ovens incorporates direct gas-fired recirculating air heating systems and other features which contribute to uniformity and faster, more economical production in a large aluminum company.

• • •

Investigate the advantages and patented features offered in the heat treating furnaces and ovens designed and built by the Carl-Mayer Corp.—write for the new, illustrated folder today. Bul. HT-53.

THE CARL-MAYER CORP.
3030 Euclid Ave., Cleveland, Ohio

Al-Mg-Si Alloys . . .

(Continued from p. 178)

free aluminum (the basis alloy), one with low iron (0.2%), and one with iron at 0.35%; each series contained 0.7% magnesium and 1.0% silicon and was further alloyed with 0.20, 0.40 or 0.60 manganese or chromium.

Metallographic examination of the chill-cast structures revealed in the basis (iron-free) alloy Al-Mg_2Si eutectic and elemental silicon. With manganese or chromium present the α-(MnSi)Al or the α-(CrSi)Al phases occurred. In the absence of either manganese or chromium, iron occurred mainly as β-(FeSi)Al or α-(FeSi)Al, but the latter phase predominates when either manganese or chromium is present. It was observed that reheating had no effect on the Al-Mg-Si alloy with 0.35% Fe, but in alloys with manganese or chromium (with or without iron) reheating caused a precipitate to form in the matrix. At 390° F. there was a general mottling of the grains which, at progressively higher temperatures, became more pronounced at the center until at 930° F. the edges of the grains appeared free of the precipitate.

In the wrought alloys, the grain boundary phase was broken up into stringers of intermetallic compound. During hot rolling, large well-dispersed particles were precipitated; this was especially apparent in the manganese and chromium-bearing alloys in which a banding also developed from the mottled core and light grain boundaries of the original cast structure. The precipitate, undoubtedly Mg_2Si, was redissolved on heat treatment and the dark bands changed in appearance, the precipitate becoming smaller in quantity and more finely dispersed so that the appearance was more uniformly gray rather than mottled. It was assumed that the as-rolled banded effect was due to a duplex precipitate with coarse particles of Mg_2Si (which redissolved) and finer ones of the less soluble complexes $(Mn,Fe)Al_6$ or $(Cr,Fe)Al_7$. Artificial aging of the Al-Mg-Si and Al-Mg-Si-Fe alloys caused the appearance of dark, uneven lines on the grain boundaries which were absent on those containing manganese and chromium.

(Continued on p. 182)



SEEING'S BELIEVING

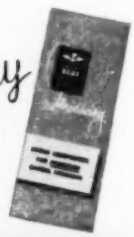
Let us prove to you that LORCO Barrel Finishing Compounds will increase metal finish, color, and luster, and reduce your operational time cycles and costs.

Send us some samples of one of your hard-to-tumble parts . . . we will tumble them in the LORCO Compound designed specifically for the metal or alloy the part is made of . . . and the cleaning and finishing job required.

When you see the uniform, low micro-inch finish, and feel the ultra-smooth surface achieved by using LORCO Compounds employed in modern media, you'll see why so many barrel finishing operations today are using the new, highly efficient LORCO Barrel Finishing Compounds. You'll realize it's time you switched to LORCO Compounds. If you prefer, we will gladly send you samples of most LORCO Compounds, so that you can conduct the test yourself.

Lorco

Write Today



for LORCO'S fact-filled Catalog. In it you'll find our Rapid Application Index, characteristics, descriptions, and field data on all LORCO Compounds.

LORD
CHEMICAL CORPORATION

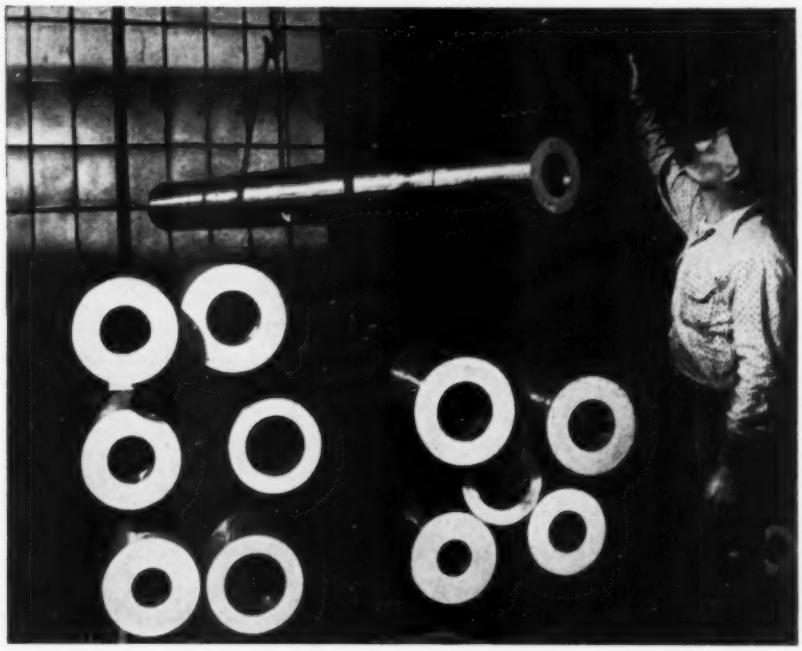
COMPLETE LINE OF BARREL FINISHING COMPOUNDS ALL TYPES OF TUMBLING BARRELS INCLUDING BENCH MODELS MEDIA AND AUXILIARY EQUIPMENT

2068 S. QUEEN ST., YORK 5, PA.

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation



New Tool Steel Saves Production Time

BTR HOLLOW-BAR IDEAL FOR ALL RING-TYPE APPLICATIONS

Making ring dies? Draw rings? Ring gages? Back-up rings? Then you'll want to use BTR Hollow-Bar, a new Bethlehem tool steel which is especially designed for this type of service.

BTR stands for "Bethlehem Tool Room," our popular oil-hardening tool steel. BTR Hollow-Bar is made by an improved Bethlehem process called High-Speed Trepanning. By this method, the center metal of the hammer-forged round bars is cored out and the bars are then rough-turned on the outside.

BTR Hollow-Bar saves production time and delivery time because your distributor can cut off rings from the bar to any desired length. It also enables you to save shop time, because there's no need to wait for forged rings or discs. What's more, in most instances there's no drilling, rough turning, rough boring, or rough-facing required.

BTR Hollow-Bar is furnished in the annealed condition to a Brinell of 202 max, and is smooth-machined on both the inside and outside surfaces. Stock lengths for small sizes are 6 ft to 8 ft, and for large sizes 8 ft to 12 ft.

Typical Analysis

Carbon	0.90	Chromium	0.50
Manganese	1.20	Tungsten	0.50
		Vanadium	0.20

If you'd like to know more about Hollow-Bar, talk it over with your distributor. Or write to us at Bethlehem, Pa.

66 HS MACHINES CAR WHEELS

Here the rim contour and front face of a "one-wear" wrought-steel freight-car wheel are being machined. The average depth of cut is 1/32 in. Both the roughing and finishing tools used in this machining operation are made of Bethlehem 66 HS. This is our moly-tungsten grade of high-speed tool steel. In addition to featuring wear- and shock-resistance, 66 HS also has good red-hardness.

BETHLEHEM TOOL STEEL ENGINEER SAYS:



It Doesn't Pay to Punch All the Way Through

One of the best ways to improve the tool life of punches is to control the stroke of the punch. It is not necessary for a punch to go completely through the hole. When a punch does go through the hole, rapid wear occurs. This increases clearance, which in time increases the load necessary for punching, and results in burred edges.

When a punch has penetrated part way through the stock, "snapping" occurs and the "button pops out." The amount of penetration of punch before "snapping" takes place depends upon the material being punched, and the stock thickness. In general, the softer the material the greater the penetration required; conversely, a hard or brittle material requires less penetration.

The penetration on soft, thin stock may be as high as 90 pct of the stock thickness. On hard, thick stock it may be as low as 40 pct. The least amount of penetration which will bring out the "button" is best. What the penetration should be must be determined on each job.

Proper control of penetration of the punch by adjustment of the stroke of the press will pay off in decreased wear on the punch, resulting in better quality parts and increased tool life.



QUICK—
ACCURATE
Temperature Readings
in Non-ferrous
Molten Metals with

XACTEMP
Trade Mark Reg. U.S. Pat. Off.
HAND PYROMETERS

Accurate to Within a Fraction of a Scale Division

The XACTEMP PYROMETER makes possible better quality control and helps toward elimination of blowholes, burnouts, sand infiltration and other flaws due to incorrect temperature . . . affords a simple, effective means for accurate temperature measurement of molten, non-ferrous metals. Well-balanced, easy to handle . . . always ready for use and requires no preliminary adjustments.

Cast aluminum and brass construction. Indicator is of medium resistance not affected by thermocouple length . . . acts rapidly . . . provided with Alnico V magnet and direct reading dial starting at 50° F. 43" stainless steel extension . . . standard 7" Marshall tip permits true readings below surface of metal. Made to give good service for years. Order at once to be sure of immediate delivery from stock.

Catalog No. MM701 Complete with Thermocouple.. **$68.50**

Catalog No. 1449-501T Replacement Thermocouple Tip..... $7.00

Ask about XACTEMP PYROMETERS for all-around general temperature checking. A full line of thermocouples available in stock.

GORDON SERVICE

CLAUD S. GORDON CO.
Manufacturers & Distributors
Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines
Dept. 15 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 15 • 2035 Hamilton Ave., Cleveland 14, Ohio

Al-Mg-Si Alloys . . .

(Continued from p. 180)

The effects of thermal treatments and alloying additions were determined on both tensile and bend test specimens, and it was shown that in the iron-free alloy, manganese and chromium progressively enhanced strength with a corresponding loss of elongation. Iron also increased strength and, when present with manganese or chromium, the effects were roughly additive. In the artificially aged alloy the same trends toward increased properties were observed—slight with respect to ultimate strength but substantial in the increase in proof stress, with a corresponding loss in ductility as measured by elongation and bend tests. Elongation values of artificially aged alloys did not exhibit the usual inverse relationship to tensile properties; in fact, the basis alloy was quite brittle and was improved with additions of iron but more significantly with manganese or chromium, the best properties being obtained with 0.2% or more of either of these latter two elements.

Further investigation of anomalies in ductility showed that in the basis ternary alloy and the iron-bearing quaternary alloy (where precipitation had taken place at grain boundaries on aging) fractures were entirely intercrystalline. In the iron-free alloys containing 0.2% of either manganese or chromium, fractures were mainly, but not entirely, intercrystalline. In all iron-bearing alloys with manganese or chromium and in iron-free alloys with 0.4% or 0.6% of either manganese or chromium, fractures were mainly transcrystalline. Comparison of these observations with metallographic studies leaves little doubt that brittle fractures are associated with a strong precipitate at grain boundaries. This was substantiated by corrosion resistance tests which demonstrated that chromium in salt-peroxide solution was more effective than manganese in preventing intercrystalline attack; in acid-salt solution chromium and manganese were equally effective.

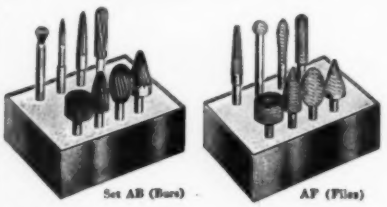
The authors' conclusion is that grain boundary fracture is caused by the low mechanical strength of a precipitate that is thrown down at the grain boundaries.

G. M. YOUNG

MARTINDALE

ROTARY BURS AND FILES

Made of high-speed steel. Produced in our own factory where uniform hardness is assured by heat-treating in electric furnaces on which the temperature is closely controlled by electric eyes.



Set AB (Burs) AP (Files)

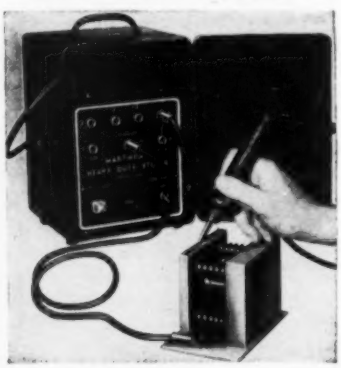
The above sets, with ¼" diameter shanks, are composed of the 8 most popular sizes for general use.
Over 200 sizes and shapes (total over 75,000 pieces) are carried in stock for immediate shipment.

DEMAGNETIZER—Model D-3



This tool quickly and easily removes magnetism from cutting tools such as cutters, drills, saws, etc., and thus keeps them free from chips and metal-slivers that reduce production. Cuts cost of tool maintenance.

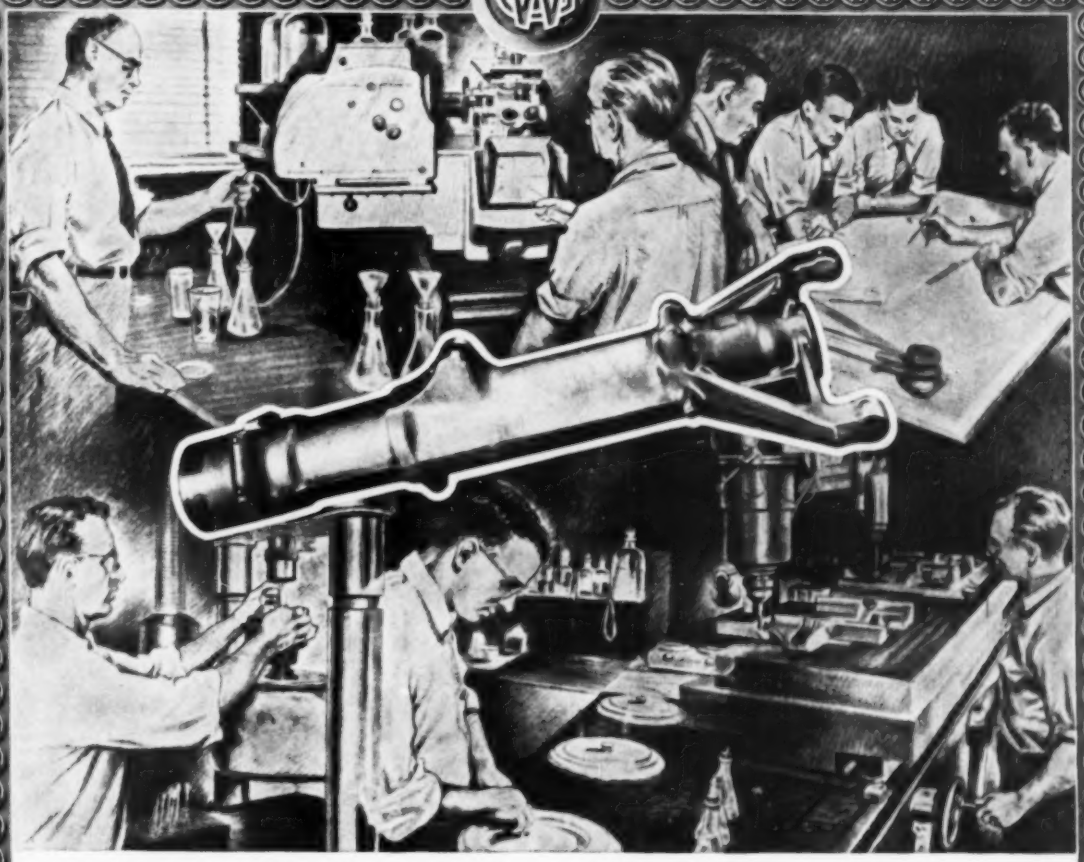
HEAVY DUTY ETCHER



Model A-A has wide use as a production-line etching tool. With six heats it is effective on small parts and also on large pieces such as shovels, castings, etc. Complete with ground lead, heavy metal case, etc.

Send for Catalog with 64 pages of Maintenance, Production and Safety Equipment.

MARTINDALE ELECTRIC CO.
1372 Hird Avenue, Cleveland 7, Ohio



FORGING TECHNICIANS—Yes, that is the compliment paid us by those acquainted with our services. In back of each design is a thorough understanding of engineering and metallurgical needs before production begins . . . assuring forgings of maximum physical properties and uniform quality

THE LANDING GEAR FORGING illustrated, nearly five feet long, is an important component for a modern military fighter . . . another example of Wyman-Gordon's technical contribution to aircraft.

There is no substitute for Wyman-Gordon experience

WYMAN-GORDON

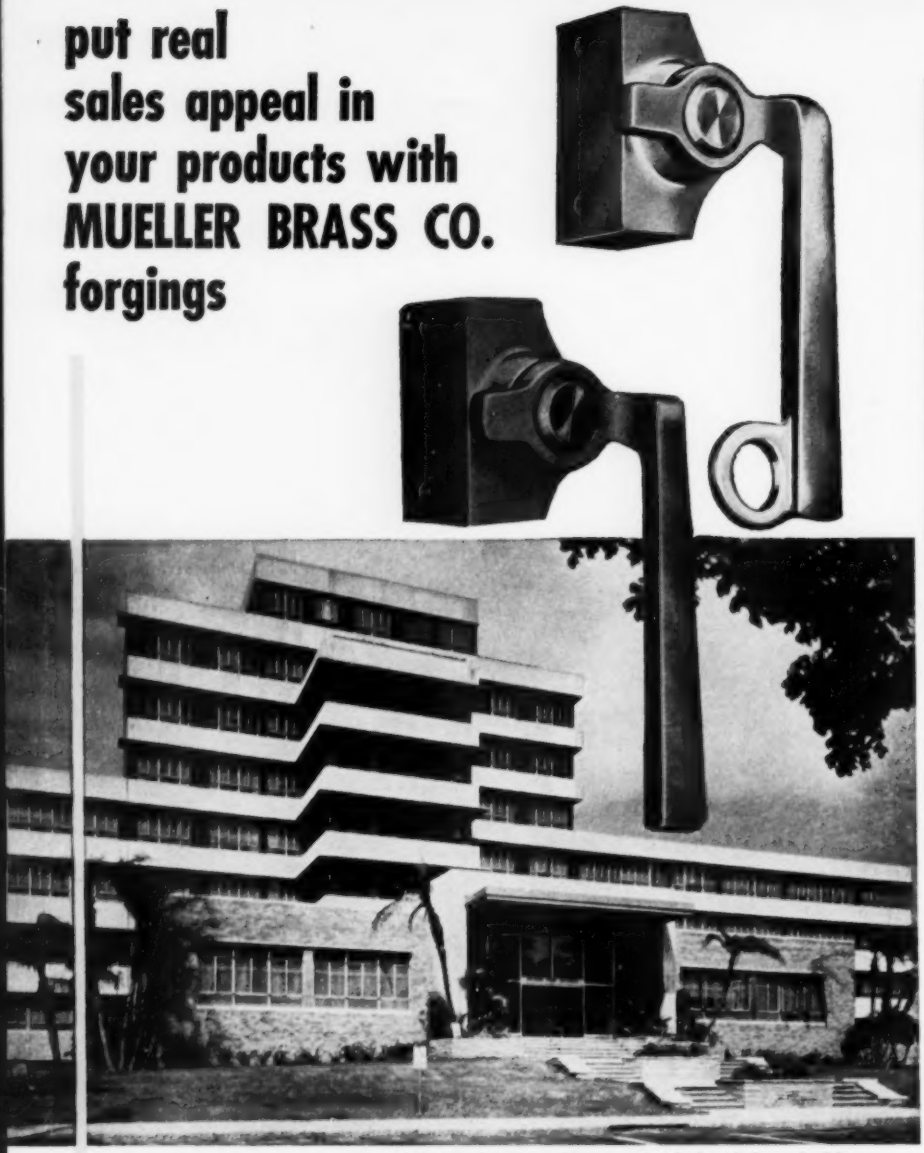
Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

put real sales appeal in your products with MUELLER BRASS CO. forgings



Windows in this modern new Florida hospital supplied by Valley Metal Products Co.—subsidiary, Mueller Brass Co.

The aluminum hardware used on all the windows in this modern hospital is a good example of the sales appeal that can be built into a product with Mueller Brass Co. forgings. These forgings are smart in design, practical in operation, and low in cost. They can also be produced in natural bronze or chrome finish depending on the desires of the architect or builder.

All Mueller Brass Co. forgings have a dense, close-grained structure with a high tensile strength. Weight savings up to 40% are possible in the design of parts because of the close tolerances to which they can be produced. Less scrap and longer tool life result from the easy machinability of forged parts. Mueller Brass Co. is completely equipped to produce brass, bronze or aluminum forgings to your specifications. For complete details, write us today.

MUELLER BRASS CO.

PORT HURON 20, MICHIGAN

Thread Inserts of 18-8 Stainless for Magnesium Components*

BROADENING applications of magnesium castings, forgings and extrusions in both commercial and military equipment have required attention to improved methods for securely fastening components. Solid bushings and screw thread inserts have been in use for many years and the accumulation of performance data has helped determine their relative merits and shortcomings, to the end that workable standards have been compiled.

Screw thread inserts of stainless steel wire offer advantages of weight saving, strength and resistance to elevated temperatures, vibration and corrosion. Such inserts, resembling springs, are in reality helically coiled, precision formed threads. In their manufacture, round 18-8 stainless steel wire, with minimum of 150,000 psi. tensile strength, is worked to a diamond-shaped cross section in specially ground carbide rolls having surface finish of 4 to 6 micro-in. The resulting finish on the wire is 8 to 15 micro-in. which produces a smooth, free-running thread. The cold working increases tensile strength to a range of 200,000 to 300,000 psi. and hardness to as high as Rockwell C-50. Final step is to coil the wire to the desired diameter and length, holding a tolerance of 0.0002 in. across flats.

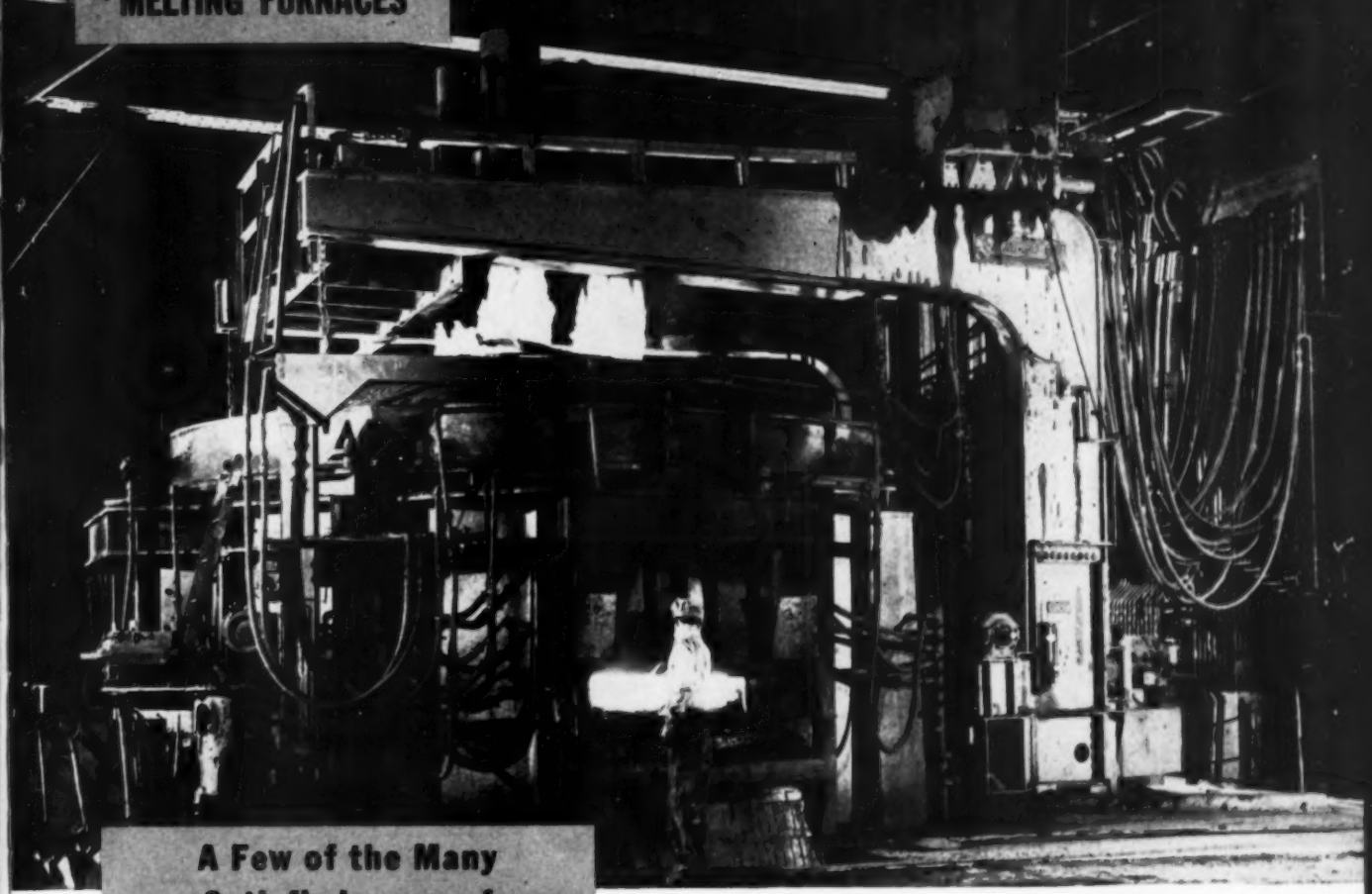
Installation, in either original equipment or repair work, is fairly simple. The bolt hole is drilled to the required minor diameter and tapped to accommodate the insert. Taps for this purpose are standard in pitch but are cut oversize in pitch diameter for the insert. Class of fit in the final assembly depends upon the tolerance held in the tapped hole. Class 2 B, for example, is widely accepted for average mass production requirements; class 2 or 3 B for closer fits, and class 3 for high precision, compatible with interchangeability.

(Continued on p. 186)

*Digest of "Performance Data: Stainless Steel Wire Screw Thread Inserts in Magnesium Applications", by Paul E. Wolfe, a paper presented at the ninth annual meeting of the Magnesium Association, New York, Nov. 2, 1953.

Heroult
ELECTRIC MELTING FURNACES

TOPS FOR PRODUCTION OF HIGH GRADE STAINLESS, ALLOY AND RIMMING STEELS



A Few of the Many Satisfied users of HEROULT FURNACES

A. M. Byers Company
Allegheny Ludlum Steel Corporation
American Steel Foundries
Crucible Steel Co. of America
Ingersoll Steel Division, Borg-Warner Corp.
McLouth Steel Corporation
Ohio Steel Foundry Company
Republic Steel Corporation
Rotary Electric Steel Company
The Timken Roller Bearing Company
Vanadium-Alloys Steel Company

NEW CATALOGUE NOW READY

Contains up-to-date information on Heroult Electric Melting Furnaces — types, sizes, capacities, ratings, etc. Write Pittsburgh Office for free copy.

Heroult
the standard of efficiency and safety!

Embodying the latest in mechanical and electrical equipment, these widely used furnaces are noted for their efficient performance, safety, and low operating cost and maintenance.

We welcome an opportunity to help you select and install the furnace best suited to your particular requirements.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco and other principal cities.
United States Steel Export Company, New York

USS

4-288

UNITED STATES STEEL

Solve Your Corrosion Problems with...

RHODIUM PLATING

Rhodium plating is finding increased use by electronic design engineers where hard, corrosion resistant electrical contact surfaces are required. Rhodium provides a stable contact resistance and allows use of higher pressures in sliding contacts.

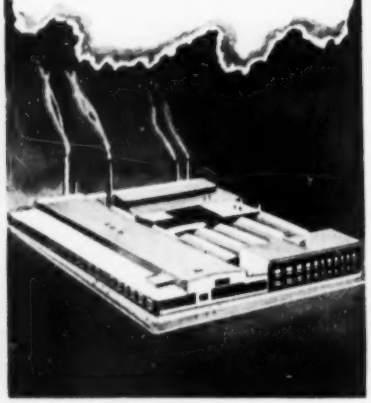
Rhodium is not affected by atmospheric changes, is free from oxide rectification and provides a low noise level. It finds many applications in the printed circuit field where it permits incorporation of sliding contacts as part of the circuit.

Write for Booklet 16.

BAKER & CO., INC.

113 ASTOR STREET, NEWARK 5, N. J.

NEW YORK • SAN FRANCISCO • LOS ANGELES • CHICAGO



Thread Inserts . . .

(Continued from p. 184)

The insert is fitted in place with either hand or power tools, Fig. 1, a slotted mandrel in the tool engaging a driving tang on the insert and compressing it so that diameter is slightly smaller than that of the tapped hole. When driving torque is released, the spring action of the insert locks it firmly into the tapped



Fig. 1 – Screw Thread of Diamond-Section Wire Is Inserted Into the Tapped Hole by Either Hand or Power Tool. The tool mandrel compresses the coil to slightly smaller diameter than the hole

threads to prevent any movement during the assembly of mating parts with cap screws or bolts. For through holes, the driving tang is notched, allowing it to be broken off easily and removed, as shown in Fig. 2.

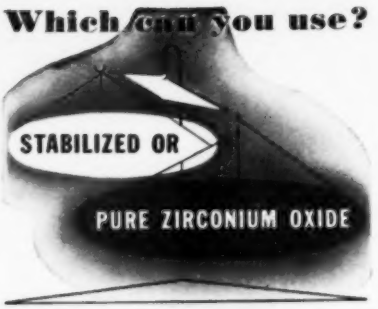
Magnesium alloys, of course, will corrode when in contact with stainless steel in the presence of an electrolyte. Similar action will occur between cadmium-plated bolts and contacting magnesium parts, although to a lesser degree, particularly if the electrolyte is of a mild variety. Occasionally it is the practice to cadmium plate the stainless steel screw thread inserts, although ten years of field experience has indicated this is not essential.

For one thing, in most assemblies, the bolt head, washer and clamped member combine to seal off the insert, bolt threads and tapped threads from exposure to corrosion conditions. Beyond that, most users specify a wet zinc chromate primer on the tapped thread to prevent metal-to-metal contact with the insert. Finally, it has been found that even if some corrosion does develop, the corrosion products serve only to lock the insert more securely.

An example of weight saving ef-

Continued on p. 188)

Which can you use?



Both oxides have definite advantages for specific uses due to their particular physical and chemical properties. Study the comparative information given here and see which will answer your requirements best.

Make note of the fact that our pure (monoclinic) oxide can be furnished in the finest grain size obtainable. We believe the purity of our oxides is unexcelled.

Typical Analysis

Pure Oxide (Monoclinic 99.2% ZrO_2)				
SiO_2 .06	TiO_2 .05	Fe_2O_3 .02	Al_2O_3 .02	BaO .003
CaO .56	MgO .04	K_2O .005	Na_2O .004	B_2O_3 .001
Stabilized Oxide (99.7% Cubic)				
SiO_2 .16	TiO_2 .10	Fe_2O_3 .11	Al_2O_3 .05	BaO .003
CaO 5.20	MgO 1.01	K_2O .001	Na_2O .003	B_2O_3 .001

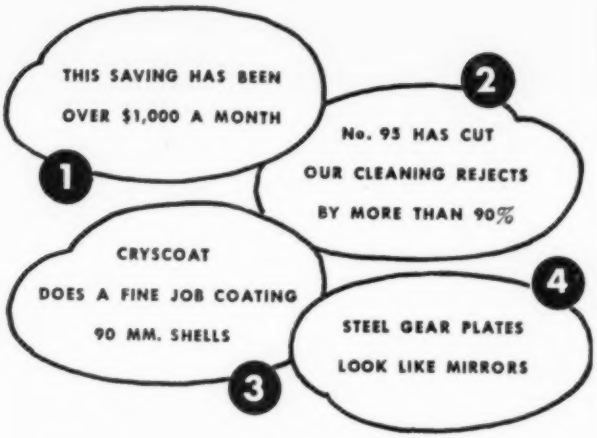
Use Characteristics

Different crystal structures account for the different successful uses of these two oxides. Pure oxide, having monoclinic crystals, undergoes an inversion of crystal structure and a 7 per cent volume change at about 1000° C. The introduction of calcium oxide, during the process of creating stabilized oxide, locks each crystal in a cubic form which remains constant to its melting point of 4700° F. The other important difference between these two oxides is the necessarily larger percentage of calcium present in the stabilized oxide. A-9579

FREE SAMPLES of either oxide are available on request. Perhaps we can help you with your particular application. **Write Zirconium Corporation of America, Solon Blvd., Solon, Ohio.**

ZIRCONIUM CORPORATION of America

MANUFACTURERS OF ZIRCONIUM COMPOUNDS



We help our customers write success stories

Every day 200 Oakite Technical Service Representatives use Oakite cleaning materials and methods to help thousands of Oakite customers accomplish metal-cleaning jobs that are important parts of big production operations.

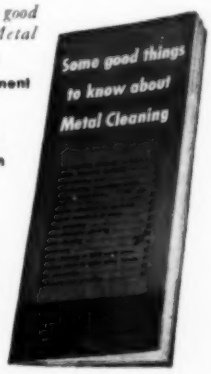
When a busy customer sends a few words of appreciation, we treasure those words as a *success sentence* that we have helped write in his *success story*. Here are brief explanations of the *success sentences* quoted above:

1. After 6 months use of Oakite Special Protective Oil for preventing rusting, this manufacturer of precision steel parts estimated savings at more than $6,000.
2. The use of Oakite Composition No. 95 for conditioning zinc-base die castings before plating cut cleaning rejects for this hardware manufacturer and showed other "very fine advantages."
3. Oakite CrysCoat HC put a heavy phosphate coating on 385,000 shells with "absolutely no trouble" according to a munitions maker, who added that "maintenance and control are very easy."
4. For burnishing, "Oakite Composition No. 3 is here to stay" says this maker of aircraft instrument parts, who adds "Pinions are polished to the roots of the gears. Magnesium parts are brilliant."

How about your success story? We'll be glad to tell you how we can help. Just drop a note to Oakite Products, Inc., 40 Rector St., New York 6, N. Y.

FREE Ask for our booklet "*Some good things to know about Metal Cleaning.*" It discusses our methods for:

- Tank cleaning
- Machine cleaning
- Electrocleaning
- Pickling, deoxidizing
- Pre-paint treatment
- Burnishing
- Paint stripping
- Rust prevention



SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. and Canada

MERRILL
MATERIALS HANDLING DEVICES



MERRILL BROTHERS
56-31 ARNOLD AVENUE
MASPETH, N. Y.

New WAUKEE FLO-METERS

for accurately measuring air . . ammonia . . dissociated ammonia . . butane . . city gas . . endothermic cracked . . exothermic cracked . . hydrogen . . natural gas . . nitrogen . . oxygen . . propane.



Here's the most important advance in flo-meter design and construction in the last 20 years . . the new WAUKEE FLO-METER!

It's easier to see flow changes. It's easier to read . . has 6" scale. It's easier to clean . . complete hand disassembly takes only seconds.

It's easier to mount . . new design permits panel mounting, simpler piping. It has built-in control valves.

And you'll like the Waukee's streamlined appearance. For additional information request bulletin #201.

Waukee **ENGINEERING COMPANY**

403 E. Michigan St., Milwaukee, Wis.



do your Ductility Te[illegible]
quick & easy

The turning of a single hydraulic control knob clamps the specimen, tests it, then releases it. The test is made in plain view, and the maximum pressure indicators show the result until reset. This highly sensitive sheet metal tester will take up to 3/16" thick specimens and exert up to 30,000 pounds pressure, at any desired rate of speed. Hydraulic mechanism is all neatly enclosed. Write for catalog sheet and prices.

DETROIT TESTING MACHINE COMPANY

9384 Grinnell Ave., Detroit 13, Mich.

Thread Inserts . . .

(Continued from p. 186)

fected through use of screw thread inserts is the redesign of a turbojet aircraft engine in which the front and mid-frames formerly were attached to the compressor case by conventional bolt and locknut. A change to inserts reduced engine weight 25 lb. by eliminating over 100 locknuts and the resultant short-

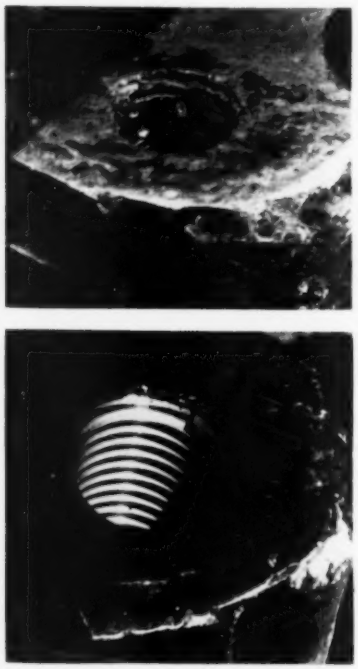
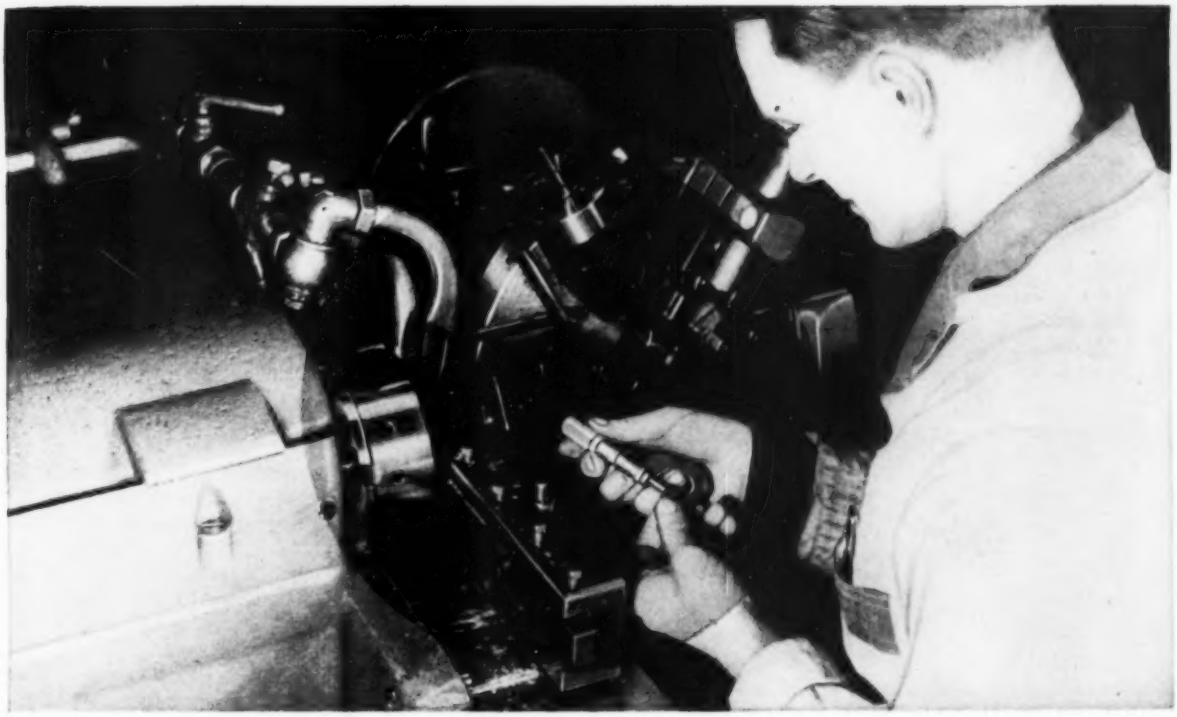


Fig. 2 – Badly Damaged Hole (Top) in Magnesium Casting Is Salvaged by Tapping Oversize and Fitting Stainless Steel Screw Thread Insert. Note driving tang on insert, gripped by a slot in the end of the mandrel for driving

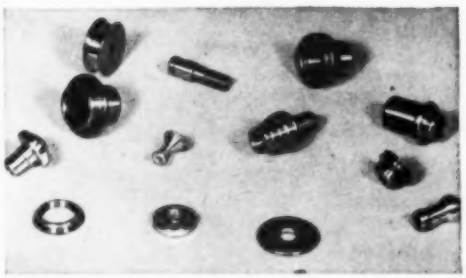
ening of the fastening bolts. Length of thread engagement on the ¾-in. bolts was figured at 1½ diameters in the forward joint and two diameters in the aft end where operating temperature exceeds 500° F.

Tests have substantiated the possibility of higher loading with screw thread inserts. The suggested explanation is that the coiled wire acts as a compensator, spreading stresses more evenly over all the engaging bolt threads, in contrast to conventional nut-and-bolt or solid bushing assemblies which concentrate load stresses over only a few threads.

A. H. Allen



TOOL LIFE INCREASED 40% USING CITIES SERVICE CUTTING OIL



ONE OIL FOR ALL? After poor results with many cutting oils, the Dunbar Machine & Tool Company discovered all their cutting jobs could be done to perfection using only one oil . . . Cities Service Chillo #44.



NO EYE STRAIN. In addition to a 40% increase in tool life, owner Robert Dunbar found that the transparent characteristics of Chillo #44 help eliminate eye strain. Cutting operation is easily visible to operator.

Production Also Up, Reports Dunbar Machine & Tool Co.

THE PROBLEM . . . The Dunbar Machine & Tool Company had a problem. It seemed impossible to find one oil which would perform economically and efficiently for ALL the jobs required of the firm's automatic screw machines.

THE SOLUTION . . . After trying many brands of cutting oil, "none of which gave good all-round performance," owner Robert Dunbar called in a Cities Service engineer. After careful analysis of the problem, the engineer recommended Chillo #44 cutting oil.

THE RESULTS . . . Using Chillo #44, the company observed these results: Tool life increased nearly 40% . . . Production increased accordingly . . . Additional savings realized due to chip draining characteristics of oil . . . Holding tolerances no longer any problem . . . Machine clean-up time now insignificant . . . Transparency of oil eliminates eye-strain . . . Less smoke and fumes at high speeds . . . Also excellent for lubricating purposes. Says Mr. Dunbar, "Our results with Chillo #44 permit us to heartily endorse this product."

If you have a cutting oil problem, consult your nearest Cities Service representative or write Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

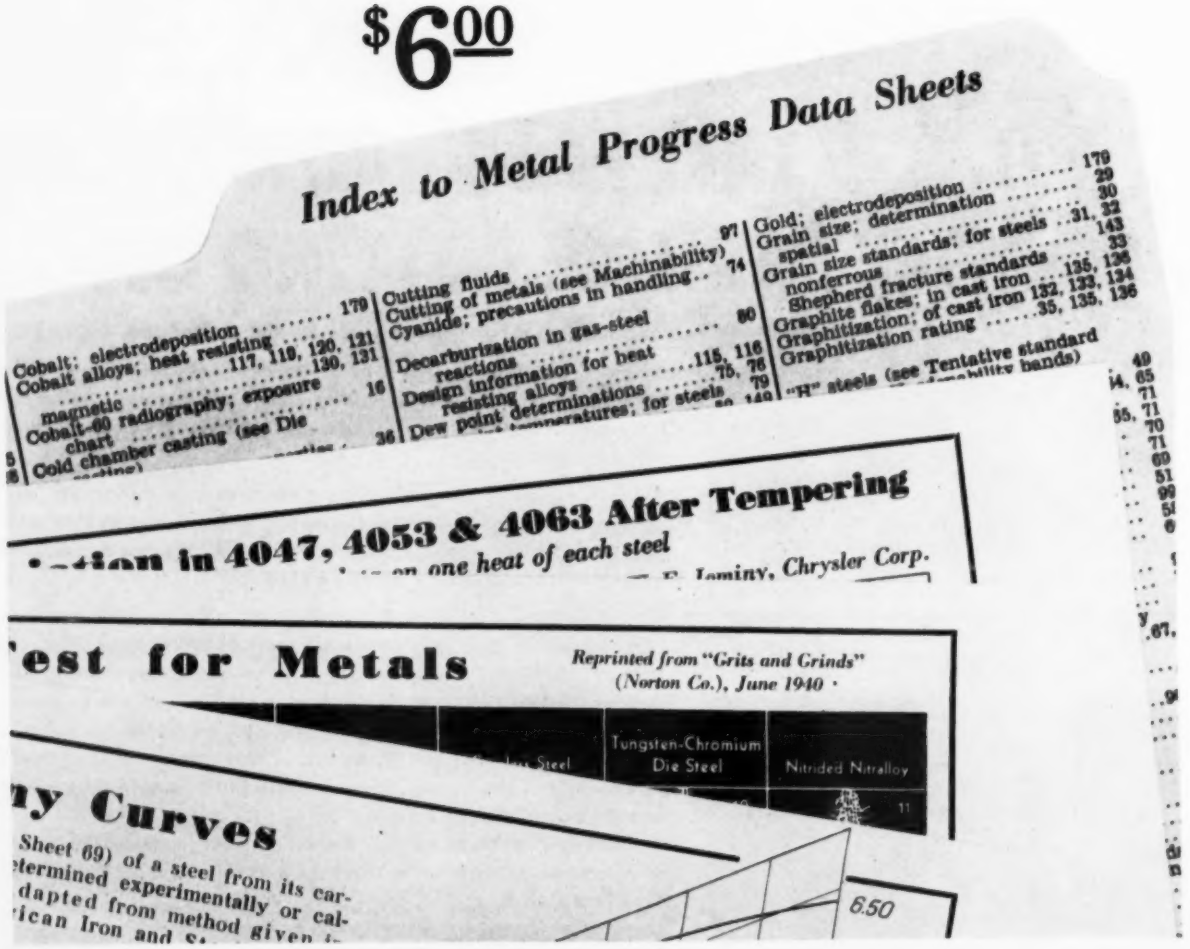
A Most Desirable Supplement to your ASM Handbook, 1948 Edition

Metal Progress Data Sheets

192 Sheets 8½"x11" loose in Envelope Binder

Subjects in all branches of Metallurgy

$6.00



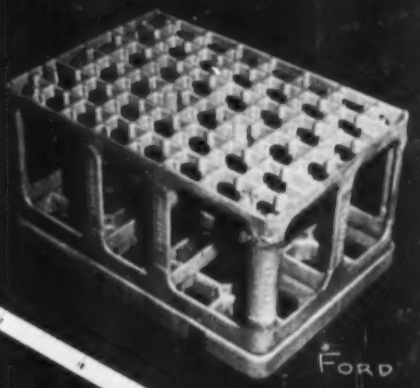
Order from American Society for Metals

7301 Euclid Avenue **Cleveland 3, Ohio**

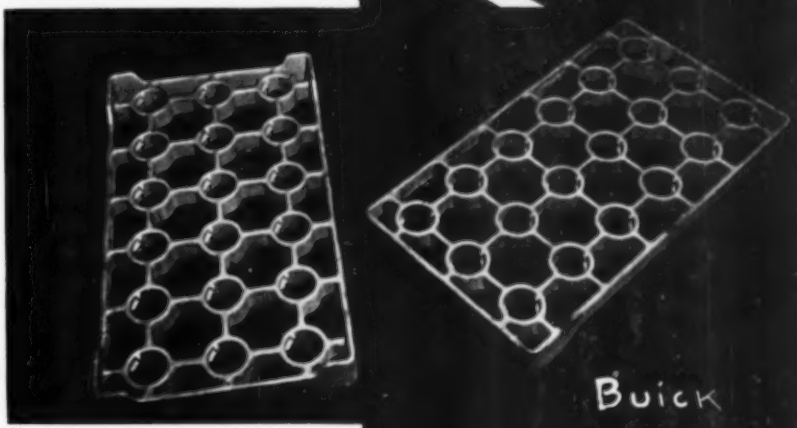
The Best in Heat-Treat Tooling!

It Can't be "Too Good" for you!

If you're really out to economize, you know, or will find out, that it *can't be done with "cheap" alloy. Intelligent cost keeping demands service records.* Accurate service records clearly reveal your alloy-cost-per-part treated. First cost, the price per pound of "castings," means little or nothing. It is cost-per-heat-hour-of-service and, *particularly, cost-per-part-treated that counts.* Top U.S. manufacturers don't operate with "cheap" alloy, any more than U.S. railroads run on dollar watches.



WITH increasing competition, *true Leaders* will turn to other *true Leaders in each* specialized industrial field to sharpen process and reduce costs. Process and product improvement come from R & D and engineering effort. The "price peddler" has a rough time ahead. *Inherently he is short in the "I.Q. Dept."* Having less & less to sell he will sell it for less & less, and produce it accordingly.



NOTE the sharp, clean detail of these G.A. castings. All interlock or interrelate in assembly with functional accuracy and *they must continue to do so* after hundreds or thousands of heat cycles. Note the small "bayonet-locks" on the inner surfaces of the "Rings" on the Buick trays. These accurately engage and locate parts treated. "Precision areas" in large castings are a General Alloys' development.

GENERAL ALLOYS products embody the *integrated* engineering, metallurgical, casting-process, and field service knowledge gained from *thirty-five years' experience* as the unquestioned leader in the engineering and production of heat and corrosion resistant alloy castings.



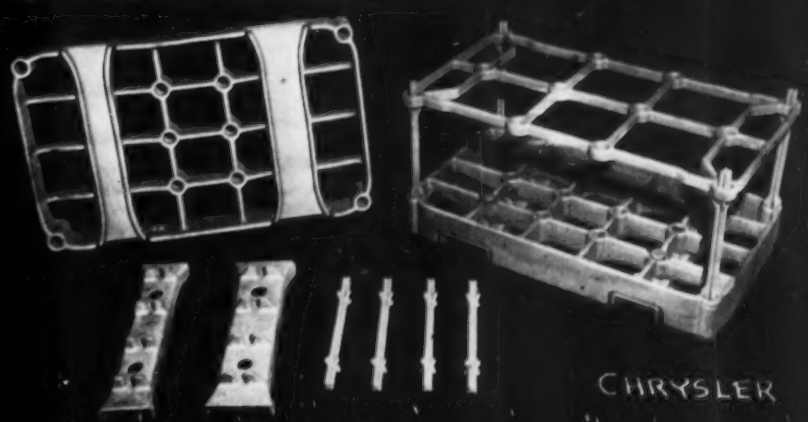
NO organization in casting history has so extensively researched all related arts, crafts and sciences for the advancement of casting design, process and service life. G.A., a National Engineering Organization, offers a complete engineering service for the design of any high temperature tooling, including any and all furnace mechanism, jet engine components, or gears, bearings and complex mechanism for dependable function at high temperatures. Similar services are available on all corrosion resistant alloy applications.

Phone, wire or write and we'll contact you direct from our nearest office.

GENERAL ALLOYS COMPANY
Boston — Mass., U.S.A.

who have, by far "the most of what there is no substitute for" —EXPERIENCE.

In engineering design, metallurgy, casting technology, and field engineering service. 35 years of it are at your service on request.



Metal Progress

Taylor Lyman, *Publisher*

A. P. Ford, *Sales Manager*

George H. Loughner, *Production Manager*
7301 Euclid Ave., Cleveland 3—UTah 1-0200

District Managers
John F. Tyrrell and John B. Verrier, Jr.
55 W. 42nd St., New York 18—CHickering 4-2713
Ralph H. Cronwell
964 W. Villa Drive, Des Plaines, Ill.—VAnderbilt 4-1206
Don J. Billings
7301 Euclid Ave., Cleveland 3—UTah 1-0200

PUBLISHED BY AMERICAN SOCIETY FOR METALS, 7301 EUCLID AVE., CLEVELAND 3, OHIO—W. H. EISENMAN, SECRETARY

• Index to Advertisers •

Acheson Colloids Corp. 36
Ajax Electric Co. 65
Ajax Electrothermic Corp. 147
Aldridge Industrial Oils, Inc. 60, 62
Allegheny Ludlum Steel Corp. 78
Allied Metal Specialties, Inc. 26
Allied Research Products, Inc. 148
Alloy Engineering & Casting Co. 6
Almco Div. 55
Alpha Corp. 62
American Brass Co. 177
American Bridge Co. 185
American Chemical Paint Co. 138
American Gas Furnace Co. 30
American Machine & Metals, Inc. 12
American Non-Gran Bronze Co. 63
American Rack Co. 53
American Roller Die Corp. 162
American Society for Metals. 165, 176, 179, 190
Ames Precision Machine Works. 170
Armour & Co., Ammonia Div. 141
Ashworth Brothers, Inc. 16

Baker & Co., Inc. 186
Bausch & Lomb Optical Co. 112D
Bell & Gossett Co. 76
Bel-Ray Co., Inc. 62
Beryllium Corp. 4
Bethlehem Steel Co. 149, 181
Boder Scientific Co. 56
Branson Instruments, Inc. 57
Bridgeport Brass Co. 136-137
Bristol Co. 26
Bundy Tubing Co. 143
Buehler, Ltd. 161

Cambridge Wire Cloth Co. 144
Cannon-Muskegon Corp. 24
Carborundum Co. 67
Carl-Mayer Corp. 180
Carpenter Steel Co. 131
Chase Brass & Copper Co. 135
Chicago Steel Foundry Co. 25
Cities Service Oil Co. 189
Clark Instrument Co. 168
Cleveland Crane and Engineering Co. 61
Cleveland Metal Abrasive Co. 53
Climax Molybdenum Corp. 178
Cold Metal Products Co. 32B
Columbia Tool Steel Co. 168
Consolidated Vacuum Corp. 129, 153
Cooley Electric Mfg. Corp. 60
Copperweld Steel Co. . . . . Back Cover
Crucible Steel Co. of America. . . . 49, 73, 112C

Deakin & Son, J. Arthur. 56
Dempsey Industrial Furnace Corp. 60
Despatch Oven Co. 134
Detroit Testing Machine Co. 56, 188
Dow Chemical Co. 171
Dow Furnace Co. 156
Du-Lite Chemical Corp. 55
Duraloy Co. 150

Ekstrand & Tholand, Inc. 64
Electric Furnace Co. . . . . Inside Back Cover
Electro Alloys Div. American Brake Shoe Co. 2
Electro Metallurgical Co. Unit of
Union Carbide and Carbon Corp. 121
Engineered Precision Casting Co. 63
Erico Products, Inc. 63

Fahralloy Co. 167
Finkl & Sons Co., A. 45
Firth Sterling, Inc. 41

General Alloys Co. 191
General Electric Co. 10-11, 75
Gordon Co., Claud S. 182
Great Lakes Carbon Corp. 79
Great Lakes Steel Corp. 139

Hanson-Van Winkle-Munning. 66
Haynes Stellite Corp. Unit of
Union Carbide & Carbon Corp. 157
Hays Corp. 60
Hevi Duty Electric Co. 27
Holcroft & Co. 32A
Hones Inc., Chas. A. 20
Hooker Electrochemical Co. 133
Hoover Co., Die Casting Div. 63
Hoskins Mfg. Co. 72
Houghton & Co., E. F. 37

Imperial Rack Co. 53
Induction Heating Corp. 28
Industrial Heating Equipment Co. 58
Industrial Rack Co. 53
Institute of Metals. 15
International Nickel Co. 39, 112A
Ipsen Industries, Inc. 32

Jelliff Mfg. Corp., C. O. 55
Johns-Manville 46

Kemp Mfg. Co. 169
King Co., Andrew. 29

Lakeside Steel Improvement Co. 57
Latrobe Steel Co. 33
Leeds & Northrup Co. 34-35
Leitz, Inc., E. 20
Lepel High Frequency Labs. 51
Lindberg Engineering Co. 174-175
Lindberg Steel Treating Co. 57
Little Falls Alloys. 64
Lord Chemical Co. 180
Lucas-Milhaupt Co. 31
Lumnite Div. 64B

Magnetic Analysis Corp. 56
Manhattan Rubber Div.,
Raybestos-Manhattan, Inc. 54
Martindale Electric Co. 182
Maurath, Inc. 63
Medart Co. 140
Meriam Instrument Co. 57
Merrill Bros. 187
Metalwash Machinery Co. 58
Metals Disintegrating Co., Inc. 142
Midvale Co. 145
Minneapolis-Honeywell Regulator Co.
(Industrial Division) 8-9, 52
Misco Fabricators, Inc. 172
Mitchell-Bradford Chemical Co. 152
Molybdenum Corp. 42
Mueller Brass Co. 184

National Carbon Co. Unit of
Union Carbide & Carbon Corp. 17
National Forge & Ordnance Co. 163
National Rack Co. 53
Nitrogen Division
Allied Chemical & Dye Corp. 164
Norton Co. 18

Oakite Products, Inc. 187
Olsen Testing Machine Co., Tinius. 40

Park Chemical Co. 151
Parker Stamp Works, Inc. 60
Pereny Equipment Co. 29
Pressed Steel Co. 125
Production Specialties, Inc. 53, 54
Puritan Mfg. Co. 53

Raybestos-Manhattan, Inc., Manhattan
Rubber Div. 54
Republic Steel Corp. 50, 77
Revere Copper & Brass, Inc. 47, 127
Revco, Inc. 16
Reynolds Metals Co. 173
Richards Co., J. A. 61
Richards Co., Inc., Arklay S. 15
Rigidized Metals Corp. 64
Roll Formed Products Co. 62
Rolock, Inc. 159
Ryerson & Son, Inc., Jos. T. 80

St. Joseph Lead Co. 48
Sandvik Steel, Inc. 69
Sargent & Wilbur, Inc. 128
Scherr Co., Inc., George 20, 25
Schnell Tool & Die Corp. 61
Scovill Mfg. Co. 43
Sel-Rex Precious Metals, Inc. 54
Sentry Co. 130
Sessions & Son, J. H. 62
Solventol Chemical Products, Inc. 5
Standard Alloy Co., Inc. 132
Standard Steel Treating Co. 60
Stanwood Corp. 59
Star Stainless Screw Co. 62
Stokes Machine Co., F. J. 38
Sun Oil Co. 14
Superior Steel Corp. 64A
Surface Combustion Corp. . . . Inside Front Cover
Swan-Finch Oil Corp. 25
Swift Industrial Chemical Co. 55
Sylvania Electric Products, Inc. 158

Taylor Sons & Co., Chas. 44
Technic, Inc. 54
Tennant Sons & Co. 154
Timken Roller Bearing Co. 7
Titanium Alloy Mfg. Div., Natl. Lead Co. . . . 74
Torsion Balance Co. 56

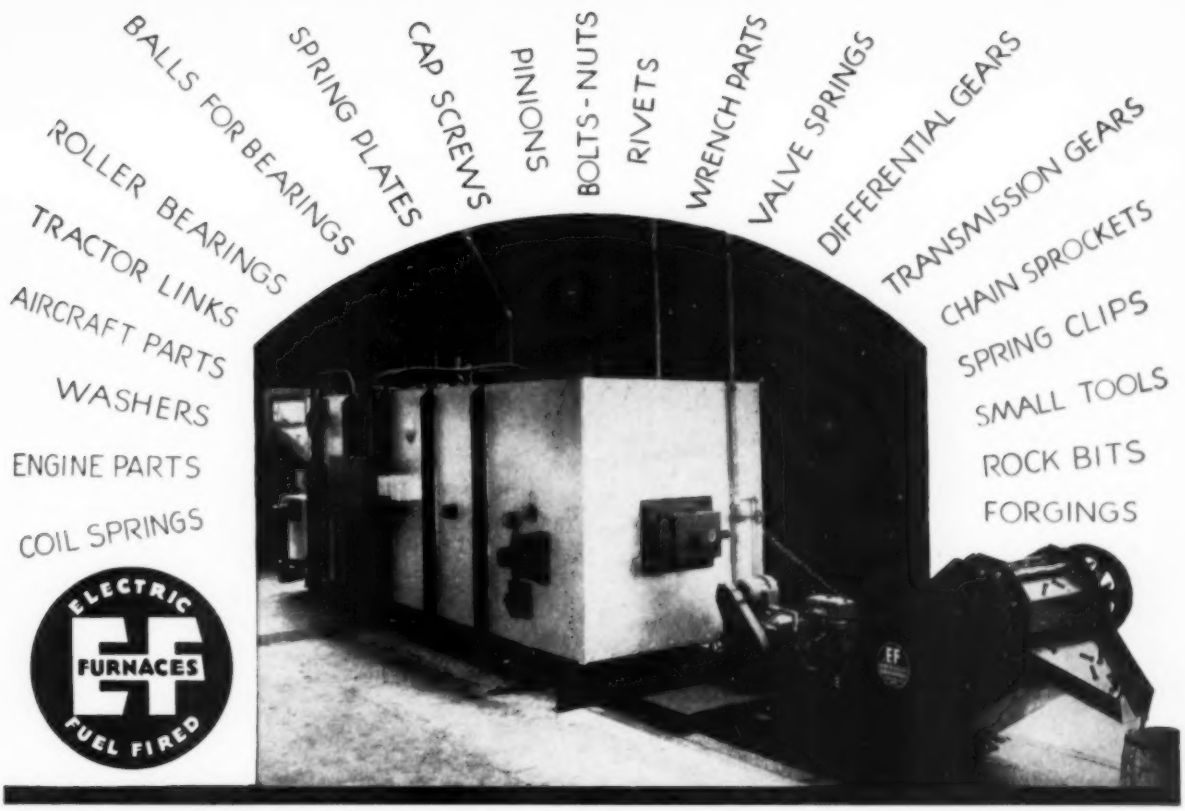
Union Carbide & Carbon Corp. 17, 121, 157
United Chromium, Inc. 70
Upton Electric Furnace Co. 59

Waltz Furnace Co. 160
Waukee Engineering Co. 188
Webber Appliance Co. 21
Western Products, Inc. 59
Westinghouse Electric Corp. 68
Wheelco Instruments Div.,
Barber-Colman Co. 22
Wheelock, Lovejoy & Co., Inc. 30
White Metal Rolling & Stamping Corp. 64
Wilson Mechanical Instruments Div.,
American Chain & Cable 155
Wiretex Mfg. Co., Inc. 58
Wyckoff Steel Co. 146
Wyman-Gordon Co. 183

Young Bros. 166
Youngstown Sheet & Tube Co. 71
Youngstown Welding & Engineering Co. 54

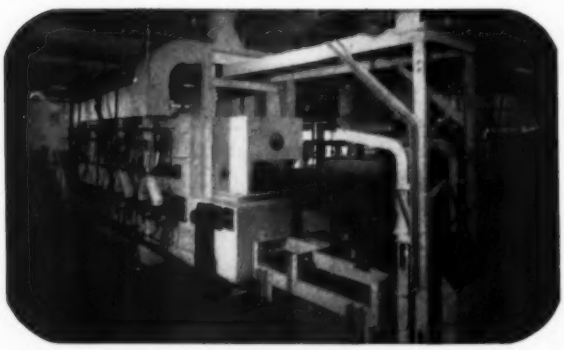
Zirconium Corp. 186

KABLE PRINTING CO.



For Hardening Small Parts

Uniformly—Scale-free—Continuously, 175 to 2000 lbs. per hr.



An EF Gas-Fired Radiant Tube Chain Belt Furnace Showing Labor-Saving Feeder. (View at top) An EF Electrically Heated Furnace Showing Automatic Quench and Discharge.

● The E F chain belt conveyor furnace is one of the most satisfactory continuous heating units yet devised for scale-free hardening, carbon restoration and non-decarb heat treating small and medium size parts. The material is loaded onto a rugged heat resisting cast link conveyor belt; carried through the furnace; heated uniformly to proper temperature; automatically quenched and discharged. No pans or trays are needed. Hundreds in daily operation prove the dependability and efficiency of our design. 11 standard sizes. Capacities to 2000 lbs. or more per hour. Gas, oil or electrically heated. Furnished complete with any desired feeding or discharging equipment. Write for folders describing our chain belt and other production furnaces.

Ask For Bulletin 461-CB.

Gas-Fired, Oil-Fired EF and Electric Furnaces

for any Process, Product or Production

THE ELECTRIC FURNACE CO.

WILSON ST. at PENNA. R. R. *Salem - Ohio*

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

COLD FINISHED

... how do you want it?

Rounds or hexes—regular carbon and alloy grades—cold drawn, rough turned, turned and polished, or centerless ground—annealed or heat treated ... cold finished Aristoloy can be furnished any way you want it. And for faster machining, longer tool life, and better finish, Aristoloy can be leaded in any of the standard A.I.S.I. or S.A.E. standard analyses.

Why shop around? We can furnish your cold finished steel requirements, and our Field Metallurgist will be glad to help you with application to your product.



COPPERWELD STEEL COMPANY
Steel Division
Warren, Ohio

ARISTOLOY STEELS

DISTRICT OFFICES

P. O. Box 1633
Tulsa, Oklahoma

1378 Union Commerce Bldg.
Cleveland, Ohio

611 Beury Bldg.
Philadelphia 40, Penna.

325 W. 17th Street
Los Angeles 15, Calif.

315 Hollenbeck Street
Rochester, New York

143 Washington Avenue
Albany, New York

Monadnock Building
San Francisco 5, Calif.

7251 General Motors Bldg.
Detroit, Michigan

117 Liberty Street
New York, New York

80 King Street West
Toronto, Ontario, Canada

1807 Elmwood Avenue
Buffalo, New York

3102 Smith Tower
Seattle, Washington

711 Prudential Bldg.
Houston 25, Texas

176 W. Adams Street
Chicago, Illinois

625 James Street
Syracuse, New York

First National Bank Bldg.
Jamestown, New York

For export—Copperweld Steel International Company,
117 Liberty Street, New York